City of Duvall **Surface and Stormwater Plan**

SEPA DRAFT – January 29, 2018



Page intentionally left blank

TABLE OF CONTENTS

TABLE	OF CO	NTENTS	I
LIST	ог Тав	LES	
LIST	of Figu	JRES	IV
Аввя	REVIATION	ONS	V
СНАРТ	ER 1.	INTRODUCTION	1-1
1.1	Why	A SURFACE AND STORMWATER PLAN?	1-1
1.2	Histo	DRY OF STORM AND SURFACE WATER MANAGEMENT	1-2
1.3	Poli	CY AND REGULATORY FRAMEWORK	1-4
1	1.3.1	NPDES Municipal Stormwater Management Program	1-4
1	1.3.2	2015 Comprehensive Plan	1-5
1	1.3.3	2015 Watershed Plan	1-5
1	1.3.4	1997 Stormwater Management Plan	1-7
1.4	Сная	PTER 1 REFERENCES	1-7
СНАРТ	ER 2.	SURFACE AND STORMWATER MANAGEMENT BACKGROUND	2-1
2.1	Curr	RENT STORMWATER MANAGEMENT PROGRAM OVERVIEW	2-1
2	2.1.1	Program Components	2-1
2	2.1.2	Coordination with Other Programs and Permit Requirements	2-5
2.2	Acco	DMPLISHMENTS SINCE 1997 STORMWATER MANAGEMENT PLAN	2-9
2.3	Снаг	LENGES AND OPPORTUNITIES FOR SURFACE AND STORMWATER MANAGEMENT	2-12
2.4	Сная	PTER 2 REFERENCES	2-16
СНАРТ	ER 3.	WATERSHED AND LAND COVER CONDITIONS	3-1
3.1	GEOI	OGIC CONDITIONS	3-1
3	3.1.1	Soil Conditions	3-2
3	3.1.2	Erosion and Landslide Hazards	3-4
3	3.1.3	Constraints and Opportunities for Surface and Stormwater Management	3-6
3.2	CLIM	ATE	3-7
3.3	LANE	OOVER	3-8
3	3.3.1	Historic Changes to Land Cover	3-8
3	3.3.2	Vegetation	3-9
3.4	Duv	ALL BASINS AND SUBBASINS	3-9
3	3.4.1	Surface Waters and Natural Resources	3-9
3	3.4.2	Cherry Creek Basin	3-11
3	3.4.3	Duvall Tributaries Basin	3-14
3	3.4.4	Weiss Creek Basin	3-22
3.5	TARG	SET RETROFIT SUBBASINS	3-24
3.6	Сная	PTER 3 REFERENCES	3-24
СНАРТ	ER 4.	SURFACE AND STORMWATER SYSTEM DESCRIPTION	4-1
4.1	OVE	RVIEW OF STORMWATER INFRASTRUCTURE	4-1

	4.1.1	Factors Analyzed	4-1
4.2	Asse	T MANAGEMENT	4-4
4.3	STOF	RMWATER FLOW CONTROL AND WATER QUALITY TREATMENT FACILITIES	4-6
	4.3.1	Cherry Creek Basin	4-7
	4.3.2	Duvall Tributaries Basin	4-9
	4.3.3	Weiss Creek Basin	4-12
4.4	DRA	INAGE, EROSION AND WATER QUALITY CONCERNS	4-12
4.5	Сна	PTER 4 REFERENCES	4-13
СНАРТ	ΓER 5.	SYSTEM ANALYSIS	5-1
5.1	Syst	EMS ANALYSIS AND PRIORITY PROJECT IDENTIFICATION METHODS	5-1
5.2	RETE	ROFIT OPTIONS	5-3
	5.2.1	Reducing Peak Flows	5-3
;	5.2.2	Improving Water Quality	5-4
5.3	STOR	RMWATER RETROFIT PROJECT EVALUATION	5-5
;	5.3.1	Retrofit Ranking Results	5-5
	5.3.2	Top Five Retrofit Projects	
5.4	Сна	PTER 5 REFERENCES	5-16
СНАРТ	ΓER 6.	FUNDING AND FINANCING PROGRAM	6-1
6.1	FISC	AL POLICIES AND FINANCIAL STATUS	6-1
(6.1.1	Future Revenue	6-2
6.2		ELOPER IMPROVEMENTS	
6.3		r Summary	
6.4		ELOPMENT FORECAST (2018 TO 2035)	
6.5		NUE REQUIREMENTS	
	6.5.1	404 Storm Drainage Operations Utility Fund	
	6.5.2	409 Capital Improvement Fund	
	6.5.3	409 Capital Improvement Fund GFC Incentives	
6.6	Сна	PTER 6 REFERENCES	6-8
СНАРТ	ΓER 7.	SYSTEM IMPROVEMENTS	7-1
7.1		RMWATER SYSTEM IMPROVEMENTS	
	7.1.1	Capital Improvement Plan (CIP) Development	
7.2		ROVEMENT PROJECTS AND PROGRAMS	
	7.2.1	Retrofit Projects	
	7.2.2	Culvert / Outfall Repair or Replacement Projects	
	7.2.3	Minor Conveyance and/or Water Quality Improvement Projects	
	7.2.4	Citywide improvement Programs	
7.3		IECT COST ESTIMATES	
7.4		EMENTATION SCHEDULE, PERFORMANCE MEASURES AND STRATEGIES	
	7.4.1	Implementation Schedule	
	7.4.2	Performance Measures	
	7.4.3	Monitoring and Evaluation Strategy	
7.5	CHAI	PTER 7 REFERENCES	7-10
CLIADI	CED 0	OPERATIONS AND MAINTENANCE	0.1

8.1	Oper	ATIONS AND MAINTENANCE	8-1
8	3.1.1	Facility and Conveyance Inspection and Cleaning	8-2
8	3.1.2	Flood Response and Non-routine Maintenance	
8	3.1.3	Maintenance Repairs	8-4
8	3.1.4	Spill Response and Illicit Discharge Elimination (IDDE)	8-4
8	3.1.5	Construction Site Inspection	8-5
8	3.1.6	Other Maintenance Activities	8-5
8.2	REVIE	W AND RECOMMENDATIONS FOR OPERATIONS AND MAINTENANCE BEST MANAGEMENT PRACTICES (BMPs)	8-5
8.3	OPER	ATIONS AND MAINTENANCE OF PRIVATE FACILITIES	8-6
8.4	Снар	TER 8 REFERENCES	8-6
СНАРТ	ER 9.	POLICIES AND REGULATION	9-1
9.1	OVER	VIEW OF EXISTING POLICIES AND REGULATIONS	9-1
9	9.1.1	Surface and Storm Water Policy	9-1
9	9.1.2	Duvall Municipal Code Regulations	9-5
9.2	Prog	RAMMATIC OPPORTUNITIES FOR SURFACE AND STORMWATER MANAGEMENT	9-7
9	9.2.1	Improved Flowpaths to Snoqualmie River and Floodplain	9-7
9	9.2.2	Low Impact Development Toolbox for Future Development	9-9
9.3	RECO	MMENDATIONS FOR PLAN IMPLEMENTATION	9-13
9.4	Reco	MMENDATIONS FOR MUNICIPAL CODE AND DEVELOPMENT STANDARD UPDATES	9-13
9.5	Снар	TER 9 REFERENCES	9-13
		mmary of Federal, State, and City implemented regulations and programs related to storm and ement.	
	_	own (inventoried within City stormwater geodatabase) facility and catch basin counts, by year.	
		bbasin Summarybbasin Signatura and catch basin country, by years	
		erry Creek Subbasin Summary	
		vall Tributaries Subbasin Summary	
		per Weiss Creek Subbasin Summary	
		cilities by Type	
		cilities by Design Basis	
		tch Basins by Type	
		nveyance by Type	
Table 4	1-5. Red	commended Component Service Life (WSDOT 2017)	4-4
Table 4	1-6. Lin	ear feet of Public Conveyance by Age (as of January 2018)	4-5
Table 4	1-7. Lin	ear feet of Private Conveyance by Age (as of January 2018)	4-5
Table 4	1-8. Cou	unt of Public Catchments by Age (as of January 2018)	4-5
Table 4	1-9. Coı	unt of Private Catchments by Age (as of January 2018)	4-6
Table 4	I-10. S	ubbasin Summary	4-7
Table 5	5-1. To	p 25 Retrofit ranking for drainage plats with existing stormwater facilities	5-6
		mmary of Existing Revenue for Operations, Maintenance and Capital Improvements of the City's	
	_	ty	
Table 6	5-2. 20	18 to 2035 Project Cost Summary	6-4

Table 6-3. 2018 to 2035 [Development Forecast	6-4
Table 6-4. Summary of 20	017 One-Time Storm Capital Charges at Seven Cities	6-6
Table 6-5. Storm Drainag	e Acreage Charge for 2018-2035 Anticipated Change in Development	6-7
Table 6-6. General Facilit	y Charge for 2018-2035 Anticipated Change in Development	6-7
Table 7-1. Stormwater Sy	stem Capital Improvement Program Project List (2018-2035)	7-2
Table 7-2. Grant funding	received between 2008-2016	7-7
Table 7-3. Existing and ar	nticipated changes in development within the City	7-8
Table 9-1. LID measures i	required by project type	9-9
Table 9-2. Single-family r	esidential (platted subdivisions), Multi-family	9-12
Table 9-3. Roadway, Trai	ls, and Sidewalk Projects	9-12
Table 9-4. Commercial Pr	rojects (may use Table 9-2 when applicable)	9-12
LIST OF FIGURES		
	Watershed Plan - Subbasin Management Designation	
_	for Puget Sound lowlands, within a natural forested area and within a develop	-
=	Zealand mudsnail. Photo: Elaine Thompson, AP	
	/cle	
	with Duvall City limits (in red) and surrounding area; the dominant geologic de	-
	reas east of the Snoqualmie River Valley are Vashon lodgment till (Qgtv, extend	
=	mmons Creek culvert replacement project under SR-203. Inset: Old Coe-Clem	
fish barrier culvert, prior	to project	3-4
Figure 3-4. Inventoried G	eologically Hazardous Areas (ESA and Stratum Group, 2017)	3-5
Figure 3-5. Average mon	thly precipitation and low/high temperatures in the Duvall vicinity	3-8
Figure 5-1. A diagram o	utlining the facility assessment and ranking process including the factors in	each scoring
category		5-2
Figure 5-2. Duvall Highlar	nds Mobile Home Park Pond	5-7
Figure 5-3. Big Rock Ridge	e Pond and Laura Vera Detention Pipe	5-9
Figure 5-4. Kasper Height	ts Pond and Bioswale	5-11
Figure 5-5. Cedarcrest Hi	gh School East Pond	5-13
Figure 5-6. Cherry Valley	Vista Detention Pipes	5-15
Figure 6-1. Summary of 2	2017 Monthly Storm Utility Rates at Seven Cities	6-5
Figure 7-1. CIP Project M	ap	7-4
Figure 8-1. Example of a	Vac-Truck for catch basin cleaning and conveyance pipe jetting (JDC, 2014)	8-3



ABBREVIATIONS

BMP: Best Management Practice **CIP**: Capital Improvement Program

CIPP: Cured-In-Place-Pipe

CITY: City of Duvall

CPI-U: Consumer Price Index for All Urban Consumers

DMC: Duvall Municipal Code

ECOLOGY: Washington State Department of Ecology (DOE)

EPA: Environmental Protection Agency

ERU: Equivalent Residential Unit **ESA**: Endangered Species Act

FEMA: Federal Emergency Management Agency

FY: Fiscal Year

GFC: General Facility Charge

GIS: Geographic Information System **GMA**: Growth Management Act

GSI: Green Stormwater Infrastructure

HPA: Hydraulic Project Approval

HSG: Hydrologic Soil Group

IDDE: Illicit Discharge Detection and Elimination

KCSWDM: King County Surface Water Design Manual

LID: Low Impact Development

NFIP: National Flood Insurance Program

NPDES: National Pollutant Discharge Elimination System

NRCS: National Resources Conservation Service

PAU: Project Assessment Unit

PGIS: Pollution Generating Impervious Surface

PSP: Puget Sound Partnership

PWDDS: Public Works Development Design Standards

ROS: Rain on Snow

SBPP: Snohomish Basin Protection Plan

SBSRF: Snohomish Basin Salmon Recovery Forum

SCSWM: Snohomish County Surface Water Management

SDOT: Seattle Department of Transportation **SEPA**: State Environmental Protection Act

SF: Square Feet

SFR: Single Family Residence

SMA: Shoreline Management Act **SMP**: Shoreline Master Program

STORM: Stormwater Outreach for Regional Municipalities

SWMP: Stormwater Management Program

TESC: Temporary Erosion and Sediment Control

TIR: Technical Information Report **TMDL**: Total Maximum Daily Load

TSS: Total Suspended Solids **UGA**: Urban Growth Area

UGAR: Urban Growth Area Reserve

WDFW: Washington State Department of Fish and Wildlife

WRIA: Water Resources Inventory Area

WSDNR: Washington State Department of Natural Resources

WSUE: Washington State University Extension **WWHM**: Western Washington Hydraulic Model



CHAPTER 1. INTRODUCTION

Surface watercourses and stormwater infrastructure support nearly all aspects of stormwater management within the City of Duvall (City). Movement of storm runoff through the landscape from ditches, pipes, and streams to the Snoqualmie River and associated aquifers directly supports fish and wildlife habitats, diverse vegetation, and other environmental features.

Drainage infrastructure within developed areas of the City ensures that storm flows are conveyed away from homes, commercial buildings, schools, and other structures, allowing for ongoing use and activity even during Fall and Winter rainstorms. Many of these developed areas have replaced native soils and vegetation with impervious surfaces including roadways, parking lots, roofs and sidewalks. Runoff from these impervious surfaces is concentrated and impacted by pollution from cars and other human activities. For these areas, storm drainage infrastructure has the important role of slowing and treating runoff before it is discharged to wetlands, streams, and ultimately the Snoqualmie River.

This Surface and Stormwater Plan is the implementing document for several elements of the City's 2015 Comprehensive Plan. The intent of this Plan is to be consistent with applicable adopted 2015 to 2035 goals and policies which focus on stormwater, watershed and sensitive areas management, while also meeting development and land use goals. This Storm and Surface Water Plan will assist the City in maintaining and advancing stormwater infrastructure and low impact development (LID) approaches that meet the 2015 Comprehensive Plan objectives. While also addressing existing stormwater needs, and support the overall vision of the community.

1.1 WHY A SURFACE AND STORMWATER PLAN?

The City's stormwater management systems are key infrastructure resources for the community, wildlife habitat, and the environment. Stormwater infrastructure includes over 40 miles of conveyance pipes and ditches along with approximately 170 stormwater facilities (vaults, detention pipes, ponds, bioswales, and stormfilters), and over 2,500 catch basins. The Surface and Stormwater Plan is a functional document that provides direction for the management of stormwater runoff entering surrounding receiving waters. Proper Stormwater management provides protection of public health and safety, public and private property, reduction in localized nuisance flooding, enhanced resilience in the face of climate change, and improvements in surface and groundwater quality, and the ecological functions of natural drainage systems.

1.2 HISTORY OF STORM AND SURFACE WATER MANAGEMENT

The City has evolved from a sparsely populated area of homes and businesses, concentrated around the Old Town center with surrounding farms and rural forest lands, to a developed (and still developing) suburban community in northeastern King County. Before the early 1990's, most residential development occurred without the benefit of formalized stormwater systems. Throughout much of the downtown area, there are no systems that detain or treat storm runoff; flows are conveyed via roadside ditches and pipes to two primary outfalls directly into the Snoqualmie River.

Residential development within the City has significantly expanded since the 1990's. These developments have been required to design and construct stormwater facilities in accordance with the King County Stormwater Design Manual (KCSWDM) as adopted by the City. Early systems provided some amount of storm runoff detention, with very little water quality treatment. Although early systems were adequate for development at the time, rapid residential development within the eastern portion of the City has increased runoff rates beyond capacities of downstream systems, or has changed the timing and volumes (hydroperiods) of conveyance to small, tributary streams within the City, such as Coe-Clemmons Creek and Thayer Creek.

In 1994, the City formed a Storm Drainage Utility, as codified within Duvall Municipal Code (DMC) Chapter

9.06. The Utility was established shortly before Public Works first efforts to complete a Stormwater Management Plan, which was adopted in 1997.

The City became a National Pollutant Discharge Elimination System Phase II Permit (NPDES Permit) holder in 2008. Coverage under the Phase II NPDES Permit authorizes discharge of stormwater to waters of the United States in accordance with the Federal Clean Water Act. Discharges covered under the NPDES Permit must effectively prohibit non-stormwater

What is Low Impact Development?

Low Impact Development (LID) is a stormwater and land use management strategy that strives to mimic pre-development hydrologic processes (i.e., infiltration into the ground, evaporation and transpiration by plants, and storage in wetlands, floodplains and the ground) by emphasizing conservation and use of onsite natural features, site planning, and distributed stormwater management practices that are integrated into project design.

discharges into storm sewers that drain to surface waters and must apply controls to reduce the release of pollutants. Additional NPDES Permit requirements include illicit discharge detection and elimination (IDDE), implementation of updated requirements for new development and redevelopment, and requirements for operations and maintenance. By the time the NPDES Permit was reissued in August 2013, overall thinking about stormwater management had shifted to an emphasis on LID. Consistent with this emphasis, the City requires new development to consider LID stormwater best management practices (BMPs) consistent with the 2016 KCSWDM, and has developed this Plan to provide additional tools for appropriate use of LID BMPs.

Regional and national changes have occurred in the way surface and stormwater are managed, with a clearer recognition of impacts to natural resources and aquatic species. The 1999 listing of Puget Sound Chinook Salmon as a threatened species under the Endangered Species Act (ESA) resulted in widespread regional surface water management changes to prevent the further decline of the species, and promote salmon population recovery. With an eye toward environmental protection and meeting Washington State Growth Management Act (GMA) requirements, the City completed comprehensive updates to Sensitive Area protection policies for streams and wetlands in 2005, including standards for surface and stormwater management facilities and discharges to these natural surface water features. Currently, the City is completing an additional update to Sensitive Area protection policies.

In a continued effort to comply with policies and regulations, DMC Chapter 9.06 has been revised several times to incorporate use of the current KCSWDM. Additionally, this chapter establishes a system of development fees and service charges to support Public Works implementation of Strom Drainage Utility programs. Many of the recommended capital projects listed in the 1997 Stormwater Management Plan have been implemented, and the City has grown significantly in the last 20 years. Residential subdivision has continued to occur throughout City limits, with corresponding increases in the network of stormwater management facilities and conveyance infrastructure.

The Storm and Surface Water Plan is organized as follows:

Chapter 1 - Introduction: Describes the purpose of this Plan, the history of storm and surface water management in the City, and the policy and regulatory setting.

Chapter 2 - Storm and Surface Water Management Background: Provides an overview of the City's current Stormwater Program and NPDES Phase II Permit compliance, accomplishments since adoption of the 1997 Stormwater Management Plan, and an introduction to the challenges and opportunities of stormwater management.

Chapter 3 - Watershed and Land Cover Conditions: Presents information on the City's subbasins, surface waters, geologic and soil conditions, and other natural resources; summarizes existing land cover and subbasin alterations, and retrofit opportunities based on subbasin conditions.

Chapter 4 - Storm and Surface Water System Description: Inventory of existing flow control and water quality facilities, conveyance systems, and drainage/erosion/water quality concerns.

Chapter 5 - System Analysis: Summary of analysis completed in support of stormwater infrastructure assessment and prioritization of retrofit actions; introduction of retrofit options useful within the City; and summary of prioritized retrofit project evaluations and predesign efforts.

Chapter 6 - System Improvements: The Capital Improvement Program (CIP) project list, estimated cost, and action options useful for each; and implementation schedule, performance measures, and strategies for CIP effectiveness.

Chapter 7 - Funding and Financing Program: Summary of existing fiscal policies and utility status, revenue requirements, and recommendations.

Chapter 8 - Operations and Maintenance: Overview of ongoing O&M, review of O&M best management practices, and recommendations.

Chapter 9 - Policies and Regulation: Overview of existing stormwater policies and recommendations for programmatic opportunities for surface and stormwater management.

1.3 POLICY AND REGULATORY FRAMEWORK

This section provides a summary of the policy and regulatory basis under which the Surface and Stormwater Plan was developed. In addition to complying with NPDES Municipal Stormwater Permit Requirements, the City recently adopted the 2015 Comprehensive Plan and 2015 Watershed Plan. These planning documents provide goals, policies, and action for management of surface waters and stormwater within the City. In addition, previously adopted priorities and policies in the existing 1997 Stormwater Management Plan are summarized.

This Plan is intended as an implementing tool to meet City-adopted surface and stormwater policy and regulatory requirements. Chapter 9 (Policies and Regulations), Section 9.1.1 details the policies summarized in this section.

1.3.1 NPDES MUNICIPAL STORMWATER MANAGEMENT PROGRAM

The City is a Phase II community under the NPDES Western Washington Municipal Stormwater Permit (Washington State Department of Ecology (Ecology) permit through the United States Environmental Protection Agency [U.S. EPA]). As a permittee, the City must create and implement a Stormwater Management Program (SWMP) which addresses five required program elements:

- 1. Construction Site Run-Off
- 2. Illicit Discharge Detection and Elimination
- 3. Operations and Maintenance of Post Construction Stormwater Facilities
- 4. Public Education and Outreach
- 5. Public Involvement and Participation

The City maintains a Stormwater System Information webpage, which includes SWMP Annual Reports and other resources related to the City's stormwater systems. Ecology also includes a resource webpage for each of the five required SWMP elements. The current NPDES Permit requires permittees to require LID principles and LID BMPs. The intent of this requirement is to make LID the preferred and commonly-used approach to site development.

1.3.2 2015 COMPREHENSIVE PLAN

The City's recently adopted 2015 Comprehensive Plan includes goals and policies that are directly relevant to the management of surface and stormwater infrastructure. These goals and policies, along with NPDES Phase II Permit requirements, provide the primary framework guiding development of the Surface and Stormwater Plan Update. The primary goal and associated policies for stormwater management is included in the Capital Facilities Element - Chapter 7:

Goal CF-8: Duvall's stormwater management system is effective, efficient, and enhanced to meet present and future population needs.

Additional relevant goals and policies are included in the Land Use Element (Chapter 2) and the Environment and Sustainability Element (Chapter 8) of the 2015 Comprehensive Plan. For some of the goals, only one or two of the underlying policies are relevant. All relevant goals and policies from the 2015 Comprehensive Plan are listed in Section 9.1.1 of this Plan.

1.3.3 2015 WATERSHED PLAN

The 2015 Watershed Plan provides guidance for improving stormwater management in the City based on watershed assessment results and the subbasin management groups established by that Plan (Figure 1-1). Subbasin management groups provide a system for regulating land use and associated development that protects and mitigates allowed impacts for high-functioning watershed processes, and that facilitates more intense land use activities to less sensitive subbasins.

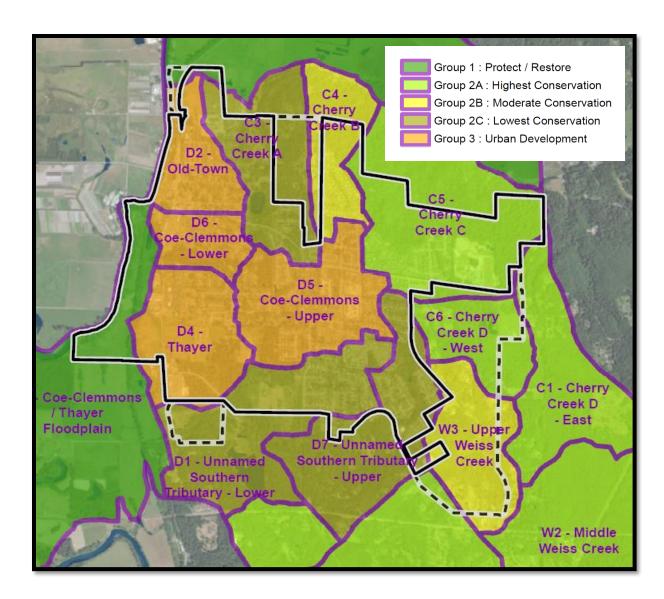


Figure 1-1. City of Duvall Watershed Plan - Subbasin Management Designation

The Watershed Plan establishes policies and prioritized actions relying on the subbasin management group framework. Each action was reviewed by a project Advisory Committee (including City staff from Public Works and Planning, and City Council and Planning Commission representatives) and ranked by feasibility and importance for achieving the City's watershed management goals. A series of actions were identified as directly relevant to management of surface and storm water from both existing uses and future development:

- Actions SW-1 and SW-3: Defining and requiring the most useful and applicable LID BMPs in new development activities, including consideration of site/development scale.
- Action SW-2: Improve soil amendment BMPs established by City code for ease of understanding and enforcement.

- Action SW-4: Establishing an expanded flow control exemption for portions of the City that are
 predominantly built-out and already drain directly to the Snoqualmie River through pipe and/or
 ditch infrastructure.
- Action SW-5: In UGAs, explore opportunity for centralized stormwater facilities to off-set onsite detention requirements.
- Action SW-6: Incentivize stormwater LID standards.
- Action SW-7: Adjust the landscape strip for street trees to be a minimum of 6-8 feet in width to
 ensure adequate space for successful growth, and encourage even wider landscape strips with
 integrated stormwater treatment and infiltration through incentives.
- Action SW-8: Specific suggestions for enhancement of the current City NPDES educational outreach program.

1.3.4 1997 STORMWATER MANAGEMENT PLAN

Although dated, the City's existing Stormwater Management Plan was reviewed for identified goals and policies. The following Water Quality Program goals were established and emphasized given "enforcement by the U.S. EPA of the NPDES Permits as a requirement of Clean Water Act":

- 1. Identify and document the locations, sources, and magnitude of water quality problems within the existing drainage system.
- Institute a program of water quality source control measures, including an expanded operation and maintenance program, regulation of development and private property, and public education with respect to water quality issues.

1.4 CHAPTER 1 REFERENCES

- City of Duvall. 2017a. Stormwater System Information web page. Available: http://www.duvallwa.gov/159/Stormwater-System-Information. Accessed November 2017.
- City of Duvall. 2016. Comprehensive Plan web page. Available: http://www.duvallwa.gov/297/Comprehensive-Planning. Accessed November 2017.
- City of Duvall. 2015. Watershed Plan. Prepared by ESA. Available: http://www.duvallwa.gov/350/Watershed-Plan. Accessed November 2017
- City of Duvall. 1997. Stormwater Management Plan. Available: http://www.duvallwa.gov/DocumentCenter/Home/View/2483. Accessed November 2017
- Ecology (Washington State Department of Ecology). 2017a. Municipal Stormwater web page. Available: http://www.ecy.wa.gov/programs/wq/stormwater/municipal/Resources4swmp.html. Accessed November 2017
- SDOT (Seattle Department of Transportation) 2014. Seattle Right of Way Improvements Manual. Available: http://www.seattle.gov/rowmanual/manual/4_14.asp. Accessed November 2017.



CHAPTER 2. SURFACE AND STORMWATER MANAGEMENT BACKGROUND

2.1 Current Stormwater Management Program Overview

This section provides a summary of current SWMP components, consistent with adopted Storm Drainage Utility (DMC Chapter 9.06) and NPDES Permit requirements. Additionally, this section summarizes connections to other related programs and requirements under which operations and maintenance, capital improvements, new development, and redevelopment activities must be completed.

The SWMP is implemented consistent with NPDES Permit Section S5.A. The SWMP is designed to reduce the discharge of pollutants from City infrastructure, to the maximum extent practicable, and to protect water quality.

2.1.1 PROGRAM COMPONENTS

The following sections detail current SWMP components, as required by the NPDES Permit and as currently implemented within the City.

Public Education and Outreach

The City's SWMP includes an education program aimed at residents, businesses, elected officials, and City staff. The goal of the education program is to reduce or eliminate behaviors and practices that contribute to adverse stormwater impacts. Public Works staff coordinate with the Snoqualmie Watershed Forum (interagency collaboration with King County Water & Land Resources Division and Snoqualmie Valley cities), King Conservation District, and non-governmental organizations — namely, Stewardship Partners.

The City has developed and maintains a stormwater webpage to help increase public awareness of stormwater related issues and provide links to useful information from other sources (Duvall, 2017a).

Public Works staff track and maintain records of public education and outreach activities, including documentation in SWMP Annual Reports. Recent and ongoing public education and outreach activities include:

- Educational activities for children and adults at Earth Day and Public Works Open House events.
- Presentations to local elementary school classes.
- City newsletter information and education updates.
- Distributing information at City Hall and specific events (Duvall Days, Farmers Market).
- Education and outreach information and links on the City's Stormwater webpage.



- Annual City-sponsored recycling event including used motor oil and household hazardous waste recycling.
- Collaboration with the Stormwater Outreach for Regional Municipalities (STORM) campaign.
- Summarizing public education and outreach activities in the SWMP annual report.
- Utility bill inserts to reach households within the City, addressing various topics including:
 - Landscaping and Yard Care design, plant selection, mulch, fertilizers, pesticides, herbicides, and compost/disposal.
 - Car washing
 - o Proper disposal of household waste, recycling, storm drain awareness, and proper disposal of hazardous household waste (paint, hydrocarbons, and antifreeze).
- Strategies to track outreach and education program success, including:
 - Community surveys (including previous comprehensive Stormwater Community Survey Program with other NPDES municipalities; Klima & Buttenob, 2009).
 - Utility billing questionnaires.

Potential Future Activities: In recent years, the City has considered implementation of additional public education and outreach activities such as:

- Installing storm drain buttons and completing storm drain stenciling including "Adopt a Drain" neighborhood stenciling and "Puget Sound Starts Here" storm drain button programs.
- Developing an Illegal Dumping and Littering program including additional awareness, signage, and trash receptacles.
- Developing natural yard care education programs.

Public Involvement and Participation

All updates to the City's SWMP and adopted Storm Drainage Utility standards over the last 20 years have been reviewed and adopted through required public involvement and participation. City Council consideration of new or updated policies include opportunity for public comment prior to Council action. In addition, recent development of the City's 2015 Watershed Plan included public and stakeholder participation through an Advisory Committee, Open House, Planning Commission review, public workshops, City Council review, survey input, and public hearings. Similar public involvement and participation efforts were completed prior to adoption of the 2015 Comprehensive Plan. As such, policies related to surface and stormwater management within the Watershed Plan and the Comprehensive Plan (detailed in Chapter 9) were adopted after opportunities for public input.

This Plan highlights the City's most recent effort to include public involvement and participation. Plan development, including analysis and prioritization for retrofit of existing facilities and strategies for future development, included input from a technical stakeholder group. This stakeholder group included City staff, technical advisors, elected officials, and members of the public. Four stakeholder group meetings



were held in 2017 with additional input throughout Plan development from the group and at City Council and Planning Commission presentations.

Illicit Discharge Detection and Elimination (IDDE)

The City's SWMP includes an ongoing program to detect and remove illicit connections and discharges as defined in the Code of Federal Regulations (40 CFR 122.26(b)(2)). The IDDE program addresses improper dumping and disposal including any spills into stormwater infrastructure owned and operated by the City.

Public Works has ongoing Geographic Information System (GIS) data collection and digitization procedures in place. Through recent efforts, the City's current stormwater system has been completely mapped and attributed within a GIS geodatabase. Updating stormwater system mapping and attributes will continue as additional system data is collected and as new development and redevelopment projects are completed in the City. The stormwater geodatabase is used by Public Works to identify upstream sources of illicit discharge, when detected.

Public Works maintenance crew personnel actively search out illicit connections as well as respond to:

- clogged storm drains;
- accidental spills; and
- other illicit discharges.

Staff Training: The City ensures that all Public Works Maintenance Crew personnel who are responsible for identification, investigation, cleanup, and reporting of illicit discharges are trained to conduct these activities. Annual training is provided as needed to address changes in procedures, techniques or requirements. The City documents and maintains records of staff trained.

Controlling Runoff from New Development, Redevelopment, and Construction Sites

The City enforces standards to reduce pollutants in stormwater runoff from new development, redevelopment and construction site activities consistent with NPDES Permit requirements. DMC 9.06.030 adopts the current edition of the KCSWDM (King County, 2016a). The City supplements the adopted KCSWDM with Duvall-specific requirements for small (DMC 9.06.040) and large (DMC 9.06.050) parcels. This gives the City Engineer additional authority to ensure that detention and water quality approaches mitigate potential downstream impacts to the maximum extent feasible.

Summary of Review, Permitting and Inspection Process: Public Works staff complete plan review, inspection, and enforcement for all project types using qualified personnel as defined by the NPDES Permit. The following steps are a general representation of these procedures:



- 1. Review of all stormwater site plans for proposed development activities, including Temporary Erosion and Sediment Control (TESC) Plans for construction activities, as well as drainage plans and supporting Technical Information Reports (TIRs) for the proposed development.
- 2. Inspect, prior to clearing and grading, all known development sites that have a potential for sediment transport.
- 3. Inspect all known permitted development sites during construction to verify proper installation and maintenance of required TESC BMPs. Enforce as necessary based on the inspection.
- 4. Inspect all permitted development sites upon completion of construction and prior to final approval or occupancy to ensure proper installation of permanent stormwater BMPs.
- 5. As part of stormwater site plan review and approval, verify an operations and maintenance plan is completed and responsibility for maintenance and ownership is assigned. Enforce as necessary based on inspection.
- 6. Document completion of all inspections.

Municipal Operations and Maintenance

In accordance with Section S5.C.5 of the NPDES Permit, the SWMP includes a pollution prevention and operation and maintenance program for municipal operations. This City program went into effect prior to the February 15, 2010 permit deadline and includes established operational BMPs and a training component with the goal of preventing or reducing runoff from municipal operations. The City program to control runoff from municipal operations is summarized in the City's SWMP Report, Appendix D. Operations and maintenance is discussed in more detail in CHAPTER 8.

Compliance with TMDL Requirements

Total Maximum Daily Load (TMDL) requirements from Section S7 of the NPDES Permit do not apply to the City because there are no TMDL's listed for the City - Appendix 2 (Ecology, 2017a).

Monitoring

Public Works is not required to implement a program of monitoring for the SWMP, because the City's population is less than 10,000 residents, and there are no listed TMDL's for the City. The City participates in SWMP effectiveness monitoring as part of the "Stormwater Monitoring Work Group" (Ecology, 2017b).

Potential Future Activities: In previous annual SWMP reports, the City has considered implementing the following additional monitoring activities:

- Identifying outfalls or conveyances where stormwater sampling (flow, temperature, etc.) may be conducted.
- Summarizing monitoring activities in future annual SWMP reports.



Annual Reporting Requirements

During the first quarter of each year, Public Works staff submit an annual SWMP report to Ecology to meet NPDES Permit reporting requirements for the previous year. Public Works staff ensure that annual SWMP reports and all other records related to NPDES Permit requirements are made available to Ecology and the public for (at least) the five most recent years (Duvall, 2016).

Each annual SWMP report includes the following information:

- Reference to the City's current adopted SWMP, storm drainage utility standards, and administrative rules relevant to NPDES Permit compliance.
- Status of implementation of each component of the SWMP consistent with NPDES Permit requirements (Sections 1 to 6), including assessment of progress towards meeting minimum measures associated with each Section.
- Description of activities implemented to comply with each component of the SWMP, including details on inspections, enforcement actions, public education and outreach activities, and IDDE (reporting includes numbers and types for all activities).
- An assessment of the relevance of BMPs identified by Public Works for each NPDES Permit requirement, and documentation and rationale of any changes made, or anticipated to be made, to BMPs that were previously selected to implement the SWMP.
- Details on implementation schedule and plans for meeting NPDES Permit deadlines for all NPDES Permit requirements where minimum measures have not been achieved.
- Any updated information to supplement prior annual reports, and any new relevant information received during the reporting period (including any storm and/or surface water monitoring or studies conducted by Public Works or other entities for subbasins within Duvall and urban growth areas).
- Notification of any annexations, incorporations or jurisdictional boundary changes and inclusion of implications for SWMP.
- Certification and signature pursuant to the NPDES Permit, and notification of any changes to authorization.

2.1.2 COORDINATION WITH OTHER PROGRAMS AND PERMIT REQUIREMENTS

A variety of land use and resource management regulations and permit requirements contribute to planning and designing stormwater infrastructure. Table 2-1 provides a summary of applicable regulations, permit requirements, and programs, and their relevance to the City.



Table 2-1. Summary of Federal, State, and City implemented regulations and programs related to storm and surface water management.

Law	Program	Intent	Relevance to the City's Stormwater Program
	NPDES Phase II MS4 Permit (Ecology, 2017a)	Regulate stormwater and wastewater discharges to waters of the state, to protect and restore surface water quality.	The NPDES Permit authorizes the discharge of stormwater to surface and ground waters from Duvall's storm drainage system. The 2013-2018 NPDES Permit is in effect as of August 1, 2013 with the latest modifications effective as of January 16, 2015. The permit requires that the City implement a Stormwater Management Program and submit annual progress reports to the Ecology (Duvall, 2016).
Clean Water Act / Federal	Water quality standards (303(d) list) (Ecology, 2017c)	Protect and restore waters so they are suitable for fishing and swimming.	Every two years, states are required to submit a Water Quality Assessment for surface waters in the state to the EPA. The Ecology compiles water quality data and waters impaired by pollutants are placed on the 303(d) list. Water bodies on the list require a water cleanup plan, typically a total maximum daily load (TMDL) prepared by the Ecology (Ecology, 2013), for each pollutant at levels greater than the water quality standards. TMDL projects can impose additional requirements on NPDES permittees. The City does not currently have any waters on the 303(d) list.
	Sections 401 (Ecology, 2017d) and 404	Protect water quality during project construction and operation in waterways	Activities that may discharge dredge or fill materials to Waters of the United States require a Section 404 permit from the U.S. Army Corps of Engineers. Any applicant for this permit must also obtain a 401 Water Quality Certification issued by the Ecology to confirm that the discharge will comply with state water quality standards.



Law	Program	Intent	Relevance to the City's Stormwater Program
Tribal Agreements and Related Case Law / Federal	Tribal Consultation, for In-Water work, Biological Assessments, and other planning efforts and permits in Duvall	Protect fisheries and other natural resources / tribal resources	The City seeks input from Environmental and Natural Resources of the Snoqualmie Tribe during SEPA review and Shoreline Permit review for development proposals and programs with the potential to affect fish habitat and water quality such as projects involving in-water work and/or new stormwater outfalls. A representative of the Snoqualmie Tribe was a member of the Watershed Planning Advisory Group, which contributed to the development of the City's Watershed Plan, which informed the City's Comprehensive Plan Update process.
National Flood Insurance Act, Flood Disaster Protection Act / Federal	National Flood Insurance Program (NFIP) (FEMA, 2017)	Reduce threats to property and public safety from flooding.	The City administers regulations on development within the floodplain, primarily through DMC Chapter 14.84, but the NFIP identifies minimum standards that must be met to maintain program participation. In exchange for the City adopting these requirements, property owners can purchase flood insurance at considerably reduced rates.
Endangered Species Act (ESA) - Federal	Listing of Chinook salmon, steelhead, and bull trout as threatened species.	Prevent further decline of the species by regulating or prohibiting "take" of the species, and designating the species' critical habitat	Chinook salmon, steelhead and bull trout are federally listed as threatened species (since 1999, 2007, and 1999, respectively). All three species of fish are present in the Snoqualmie River. The City participates in Water Resources Inventory Area (WRIA) 7 salmon conservation planning through the Snoqualmie Watershed Forum and other programs. Surface and stormwater management implications for Chinook salmon, bull trout, Coho and other salmonid population habitats include: water temperature, pollutant loading, hydrologic changes, and spread of invasive/noxious plant species.



	_		Relevance to the City's Stormwater	
Law	Program	Intent	Program	
	Snohomish Basin Protection Plan (SBPP, 2015).	Provide direction on recovery actions that will protect fish and wildlife habitat by protecting hydrology.	The 2015 SBPP examined tools that help support the goal of improving hydrologic processes, focusing on protection, not restoration. The City utilized this approach and protection tools by incorporating a watershed planning effort. The 2015 Comprehensive Plan contains goals and policies supporting salmon habitat, including removing existing (and preventing future) fish barriers.	
	Snohomish River Basin Salmon Conservation Plan (SRBSCP, 2005)	Develop a local salmon recovery response in coordination with regional efforts, focused on habitat protection and restoration.	The City is a member of the Snohomish Basin Salmon Recovery Forum (SBSRF), which adopted the Plan in 2005. The Plan presented a 50-year vision for salmon recovery and focused on specific goals to be accomplished over ten years. It contains specific recommendations for managing stormwater for salmon habitat and water quality protection.	
State Environmental Policy Act (SEPA) - State		Identify and analyze probable environmental impacts of a proposal and modify or deny a proposal to avoid, reduce, or mitigate for these impacts.	The City reviews proposals and issues SEPA determinations. Any agency "action" that is not categorically exempt requires SEPA environmental review. Actions can include specific project actions such as the construction of a City facility, and non-project actions such as updates to stormwater regulations.	
Shoreline Management Act (SMA) - State	City of Duvall Shoreline Master Program (SMP) (Duvall, 2017c)	Protect shoreline resources (ecological, economic, aesthetic) and encourage shoreline land uses that enhance and conserve shoreline functions and values. Implemented by DMC Chapter 14.78.	The City is in the process of updating its Shoreline Master Program, last updated in 1974, to comply with SMA requirements. The SMP contains regulations for managing shoreline in the City. This includes where stormwater facilities may be located and measures required to minimize impacts of stormwater runoff within shoreline jurisdiction.	
Hydraulic Code – State	Revised Code of Washington	Protect fish and their habitat	Since 1943, hydraulic projects that will "use, divert, obstruct, or change the natural flow or bed of state waters" must obtain a Hydraulic Project Approval (HPA) from Washington Department of Fish and Wildlife WDFW (WDFW, 2017).	



Law	Program	Intent	Relevance to the City's Stormwater Program
Growth Management Act – State	City Comprehensive Plan, City zoning and critical areas regulations	Regulate land use and growth while providing essential public facilities and services and protecting sensitive environmental resources	The 2015 Duvall Comprehensive Plan and supporting municipal code regulations address surface and stormwater goals, BMPs, and regulations.
Puget Sound Partnership (PSP) - State	Action Agenda (PSP, 2017)	Protect and restore habitat and economic resources in Puget Sound	The Action Agenda outlines strategies and specific actions needed to protect and restore water quality, quantity, and habitat, in Puget Sound, and the entire watershed. One of the Strategic Initiatives of the Action Agenda's Implementation Plan is to prevent pollution from stormwater runoff. Although the PSP has no regulatory authority, it creates funding incentives for advancing Puget Sound recovery goals. For example, stormwater retrofit efforts prioritizing restoration of natural stream flows and cool, unpolluted waters would contribute directly to meeting recovery targets established in the Action Agenda.

2.2 ACCOMPLISHMENTS SINCE 1997 STORMWATER MANAGEMENT PLAN

The following highlights City efforts, investigations, and capital improvements completed in the last 20 years:

2003: NPDES Permit regulations went into effect.

2003: City removed two Thayer Creek culverts in the Snoqualmie floodplain (within McCormick Park), restoring channel and surrounding riparian vegetation, replacing the culverts with precast concrete bridge spans.

2005: City installed two beaver deceivers in Coe-Clemmons Creek to discourage beaver dam construction that can obstruct fish migration in the stream.

2007: The Ecology issued the Western Washington NPDES Permit. Requirements are phased in throughout the five-year permit period. Permit was modified in 2009 to be effective through July 31, 2013. Duvall implemented the following programs and policies as required by the NPDES Permit:

• Public education and outreach program to lessen behaviors and practices that cause or contribute to adverse stormwater impacts (prior to the permit deadline).



- Illicit Discharge Detection and Elimination (IDDE) Program, including components for the public and Public Works Municipal Operations & Maintenance activities.
- Additions to the City's reporting efforts included: Public involvement and participation program, public hotline comment and reporting number, and the City's stormwater web page. Also included in these efforts - completing public notices, City Council presentations, and other public presentations; to collect, document, and implement public feedback (prior to the permit deadline).

August 2009: Adopted City Ordinance No. 1090, DMC Section 9.06.35, which addresses runoff from new development, redevelopment, and construction sites, while also prohibiting illegal discharges, and/or dumping into the stormwater system.

• Implemented a training program for staff responsible for implementing these new regulations.

August 2010: Adopted City Ordinance No. 1098 – adopting the KCSWDM.

2010: City received a grant from Snoqualmie Watershed Forum to remove knotweed along the Snoqualmie and in the floodplain.

2011: Carrie Rae Pond Retrofit. Utilized \$155,020 in Stormwater Retrofit grant funding from Ecology. This project included retrofitting a 4,000-square foot pond that was constructed as a flow-through stormwater facility in 1985 and provided no water quality improvement or detention. The retrofit increased pond depth and volume to provide water quality and flow control within the existing pond footprint. Construction of this project began in 2012.

2011: Provided and maintained a non-emergency email reporting link on City's Stormwater/NPDES web page.

2011: Revised DMC Section 9.06.125 (Service Charges) to provide a stormwater fee discount for non-residential sites utilizing pervious surfacing and documenting annual maintenance of on-site stormwater facilities.

August 1, 2013: 2013 to 2018 NPDES permit went into effect. Requires an increased frequency of catch basin inspections, among other requirements.

2013: Preparedness Calendar: included a month dedicated to Stormwater education. Calendar was mailed to approximately 7,900 households in Duvall and the surrounding Snoqualmie Valley area.

2015: Taylor Park Wall Stabilization - Coe-Clemmons Creek flows through a ravine in Taylor Park with forested steep slopes. Upstream increases in runoff from developed areas have led to increased channel erosion and slope failure near a playground and basketball court in the park. The project installed a soldier pile wall immediately behind the top of the slope to stabilize the park area.

2015: Adoption of 2015 Watershed Plan and 2015 Comprehensive Plan addressing surface and stormwater goals, BMPs, and regulations.



2015: Completed SR-203 Coe Clemons Creek Culvert replacement project in partnership with WSDOT. Project included removal of 6-foot wide sediment-filled box culvert and replacement with 25-foot wide fish-passable culvert.

2016: King County updated their Surface Water Design Manual, effective April 24, 2016, with new standards for low impact development (LID). Duvall Code adopts the "current version" of the Manual. Manual updated to "improve the clarity and cost effectiveness of its requirements" and be equivalent with the state's 2012 Stormwater Management Manual for Western Washington (amended in December 2014).

2016/2017: Bowe Court (private residential development) incorporated LID elements throughout – such as drywells, pervious pavers, and bioretention swales – to significantly reduce runoff from impervious surfaces, eliminating the need for a detention facility. This project, along with other initial development projects implementing LID approaches in the City, have been approved by Public Works. Integration of LID elements as privately owned stormwater BMPs requires implementation of an operations & maintenance program that is the responsibility of the developer.

2016/2017: Parkwood Estates Pond Retrofit project: Retrofit an existing flow through stormwater pond that was originally constructed in 1986 as a single cell, asphalt-lined pond with little or no water quality BMPs. The new design includes a water quality wetpond, removal of the pavement liner and replacement with vegetated slopes, a biofiltration swale to improve water quality, and retention of existing mature conifers.

February 21, 2017: Adopted Ordinance No. 1214 to DMC 9.06 (Storm Drainage Utility). Updated Stormwater regulations and restrictions to incorporate and require LID principles and LID BMPs, as required by the NPDES permit.

2017: Completed Thayer Creek Culvert replacements at SR-203 (Main Street) and NE 143rd Place crossings as part of the City of Duvall Main Street South reconstruction project. The project included removal of a 24-inch diameter culvert on SR-203 and a 30-inch diameter culvert on NE 143rd Place and replacement with 7-foot wide fish passable culverts at both locations.

Ongoing projects, programs, or partnerships:

- Snoqualmie floodplain wetland and stream restoration efforts:
 - There are several completed and ongoing restoration projects. Objectives include restoring shoreline bank conditions; removing invasive plants; installing native plants; enhancing fish habitat; improving water quality and hydrology functions in tributary streams; reducing sediment loading, erosion, and stormwater impacts to creeks; and stabilizing banks at key locations.
 - Restoring lower Coe-Clemens Creek and associated wetlands. Planting native vegetation in wetland and stream buffers (2009: planted a half acre of wetland and stream buffer along Depot Creek. Included a pervious concrete walkway.)
- Updating the GIS stormwater and facilities geodatabase.



- Stormwater Outreach for Regional Municipalities (STORM) education and outreach.
 - o Formed the "Puget Sound Starts Here" campaign with Puget Sound Partnership.
 - o Continued installation of "Puget Sound Starts Here" storm drain buttons.
- Growing network of stormwater facilities and catch basins (Table 2-2).

Table 2-2. Known (inventoried within City stormwater geodatabase) facility and catch basin counts, by year.

Year	Known Facilities	Known Catch Basins
2010	82	1590
2012	89	1640
2014	100	1871
2015	100	1890
2016	125	2206
2017	170	2500

2.3 CHALLENGES AND OPPORTUNITIES FOR SURFACE AND STORMWATER MANAGEMENT

The following section provides an overview of the complexities of managing stormwater within the City. This includes existing development and infrastructure, redevelopment, new development, and integration of LID or green infrastructure approaches.

Aging Infrastructure and Asset Management

Repair and replacement of aging and failing infrastructure is important to prevent catastrophic failures that may cause flooding or public safety hazards. The City implements facility inspection and maintenance consistent with NPDES Permit requirements (see summary in 2.1.1 for details). Opportunities for a more systematic, proactive asset management would support Public Works in maintenance and completing improvements to aging stormwater infrastructure. Approaches could include:

- Implementing a City-wide asset management software tool.
- Standardized and digitized field inspection forms (tablet-based), linked to stormwater infrastructure database or software tool.



• Including long-term asset management costs in requirements for new facilities, through incentives encouraging LID or green infrastructure approaches.

This Plan is also implementing analysis to prioritize stormwater facility retrofit actions in areas of greatest need (see Chapter 5 - System Analysis for details). For other recommendations focusing on inspection, maintenance, and repair of infrastructure; see Chapter 8 - Operations and Maintenance.

A Shift Toward Low Impact Development

The NPDES Permit now requires permittees to adopt LID site-scale standards and update development related codes requiring use of LID principles and facilities. In addition, requiring the adoption of the Ecology's 2012 Stormwater Management Manual for Western Washington or approved equivalent (2016 KCSWDM is an approved equivalent). These manuals emphasize the incorporation of LID standards and have a new flow control performance standard for small projects (2,000-square feet of new or replaced impervious surface). The City took initial steps toward compliance with new NPDES Permit requirements with adoption of Ordinance No. 1214 in early 2017, and is taking additional steps through development of this Plan.

The use of LID for stormwater management presents a significant shift from a purely structural approach for detention and treatment of runoff, to a source reduction approach (PSP and WSUE, 2012). Traditional "grey" infrastructure does not encourage use of integrated site planning, resulting in significant impervious surface coverage which routes or conveys (through inlets, catch basins, and pipes) storm runoff to a centralized facility.

In urban developed areas, impervious surfaces such as parking lots, streets, sidewalks, and roofs have replaced areas that historically stored and infiltrated precipitation. Precipitation sheds off impervious surfaces and is collected in conveyance pipes, which is then routed to a facility or discharged directly to a receiving water body. Unless this runoff is properly managed, it contributes to high flow rates during storm events; increasing flooding, and threatening private property, roads, utilities, and other important infrastructure. High flows also damage and destabilize stream banks and habitat, making conditions less suitable for fish spawning, rearing and migration. Stormwater runoff also picks up pollutants from pollution generating impervious surfaces (parking areas, roads, etc.), degrading water quality when discharged directly to water bodies.

Alternatively, LID approaches emphasize site planning as an integral part of stormwater management. The intent of LID is maintaining "a more hydrologically functional landscape even in denser settings" (PSP and WSUE, 2012). Figure 2-1 illustrates the differences in how precipitation moves through a natural, undeveloped area as opposed to typical developed areas. Integrating LID BMPs into developed areas restores some of the natural hydrologic functions resulting in; improved water quality, reduced flooding, and reduced stream erosion.



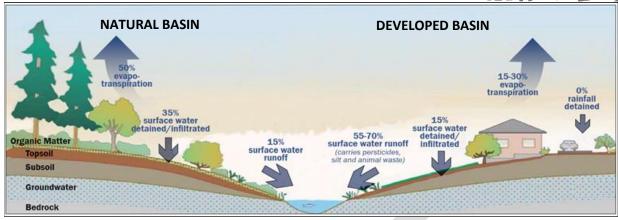


Figure 2-1. Water budget for Puget Sound lowlands, within a natural forested area and within a developed area (PSP & WSUE, 2012)

Establish Flow Control Exemption

Creating an extended flow control exemption is consistent with policy recommendation SW-4 from the City's Watershed Plan and allowances provided by KCSWDM and NPDES Permit. This would affect portions of the City that are predominantly built-out and already drain directly to the Snoqualmie River through pipe or ditch conveyance.

Invasive Species Management

Invasive and noxious plant species are common in stormwater facilities. The King County Noxious Weed Control Board requires the control of several species of noxious weeds that may be found in facilities within the City, such as:

- purple loosestrife (Lythrum salicaria)
- policeman's helmet (Impatiens glandulifera).

Other invasive plants, not listed, can be damaging to the functioning of stormwater facilities including:

- Himalayan blackberry (Rubus armeniacus)
- Reed canarygrass (Phalaris arundinacea)
- Japanese knotweed (Polygonum cuspidatum)

Stormwater conveyance systems and stream corridors can be a vector for the spread of invasive plant species. Typical travel routes are from developed areas to downstream waters, or from agricultural areas into the City. Therefore, managing current invasive plants that are prevalent, and recognizing risks from other invasive species, is an important component of maintaining vegetated facilities. Control of invasive plant species maintains the proper function of facilities, and prevents spread to other aquatic resources.

New Zealand mudsnail (a potential future threat): As of 2017, the New Zealand mudsnail has not been found in the Snoqualmie Watershed. However, they have been identified within several nearby areas



(including in the lower Snohomish River near Everett, and in multiple basins draining to Lake Washington). The New Zealand mudsnail, as seen in Figure 2-2, is a non-native species that has no natural predator, parasite, or disease to control population size in North America. Although the full understanding of implications for Puget Sound lowland streams remains unknown, the species can multiply very quickly and has the potential to become a serious economic and ecological problem (King County, 2016b). They are known to reproduce to extremely high densities, crowding out native vegetation, insects, fish, and potentially changing water chemistry. City staff should continue to monitor the presence of New Zealand mudsnails within vicinity streams and basins. Coordination with King County to take necessary preventative steps to minimize potential for spread into the Snoqualmie River and tributary basins is recommended.



Figure 2-2. Invasive New Zealand mudsnail. Photo: Elaine Thompson, AP

Targeted Residential Property Owner Outreach

The City currently implements public education and outreach that targets property owners. Review of current efforts, and focused updates to target residential property owners may be the most effective way to improve stormwater practices and reduce runoff from areas of existing development. Single family homes are by far the most prevalent throughout the City. Potential approaches could include:

- New guidance and outreach focused on natural yard care, including integration of stormwater pollution prevention information sheets for residential uses developed by King County (King County, 2017c).
- Implementing rain garden resources and incentives program (in partnership with Stewardship Partners).
- Supporting pilot projects with interested property owners, with agreement to serve as educational examples for others.



2.4 CHAPTER 2 REFERENCES

- City of Duvall. 2016. Stormwater Annual Report web page. Available: http://wa-duvall.civicplus.com/Archive.aspx?AMID=36. Accessed November 2017.
- City of Duvall. 2017a. Stormwater System Information webpage. Available: http://www.duvallwa.gov/159/Stormwater-System-Information. Accessed November 2017.
- City of Duvall. 2017b. Shoreline Master Program Update web page. Available: http://www.duvallwa.gov/137/Shoreline-Master-Program-Update. Accessed November 2017.
- City of Duvall. 2017c. Stormwater Pollution Prevention Plan for Municipal Heavy Equipment Maintenance, Storage Yards, and Material Storage Facilities. March 2016 Update. Available: http://www.duvallwa.gov/DocumentCenter/Home/View/343. Accessed November 2017.
- Ecology (Washington State Department of Ecology). 2013. Total Maximum Daily Load List web page.

 Available: http://www.ecy.wa.gov/programs/wq/tmdl/tmdlstrategy.html. Last updated June 2013.

 Accessed November 2017.
- Ecology (Washington State Department of Ecology). 2017a. Phase II Western Washington Municipal Stormwater Permit web page. Available: http://www.ecy.wa.gov/programs/wq/stormwater/municipal/phaseIIww/wwphiipermit.html. Accessed November 2017.
- Ecology (Washington State Department of Ecology). 2017b. Stormwater Work Group web page. Available: http://www.ecy.wa.gov/programs/wq/psmonitoring/swworkgroup.html. Accessed November 2017.
- Ecology (Washington State Department of Ecology). 2017c. Water Quality Assessment and 303(d) List webpage. Available: http://www.ecy.wa.gov/programs/wq/303d/index.html. Accessed November 2017.
- Ecology (Washington State Department of Ecology). 2017d. Federal Permits web page. Available: http://www.ecy.wa.gov/programs/sea/fedpermit/index.html#What_is_a_401_Water_Quality_Certification. Accessed November 2017.
- FEMA (Federal Emergency Management Agency). 2017. The National Flood Insurance Program web page. Available: https://www.fema.gov/national-flood-insurance-program. Last updated September 15, 2017. Accessed November 2017.
- King County. 2016a. King County Surface Water Design Manual. April 24, 2016. Available: http://www.kingcounty.gov/services/environment/water-and-land/stormwater/documents/surface-water-design-manual.aspx. Accessed November 2017.
- King County. 2016b. New England Mudsnails web page. Available: http://www.kingcounty.gov/services/environment/animals-and-plants/biodiversity/threats/Invasives/Mudsnails.aspx. Last Updated November 20, 2016. Accessed November 2017.
- King County. 2016c. Residential Best Management Practice (BMP) Activity Sheets web page. Available: http://www.kingcounty.gov/services/environment/water-and-land/stormwater/documents/pollution-prevention-manual/residential-bmp.aspx. Last updated August 8, 2016. Accessed November 2017.



- Klima, K. and B. Buttenob. 2009. Stormwater Community Research Report. September 2009. Herbert Research, Inc. Available: http://www.duvallwa.gov/DocumentCenter/Home/View/338. Accessed November 2017.
- PSP (Puget Sound Partnership) and WSUE (Washington State University Extension). 2012. Low Impact Development Technical Guidance Manual for Puget Sound. December 2012. Available: http://www.psp.wa.gov/downloads/LID/20121221_LIDmanual_FINAL_secure.pdf. Accessed November 2017.
- PSP (Puget Sound Partnership). 2017. Action Agenda for Puget Sound web page. Available: http://www.psp.wa.gov/action_agenda_center.php. Accessed November 2017.
- SBSRF (Snohomish Basin Salmon Recovery Forum). 2005. Snohomish River Basin Salmon Conservation Plan. Snohomish County Department of Public Works, Surface Water Management Division. June 2005. Everett, WA. Available: http://www.govlink.org/watersheds/7/pdf/WRIA%207_Plan/Final_Compiled_Plan.pdfAccessed November 2017.
- SCSWM (Snohomish County Surface Water Management), King County SWF (King County Snoqualmie Watershed Forum Staff), and Tulalip NRD (Tulalip Tribes Natural Resources Department). 2015. Snohomish Basin Protection Plan. Snohomish Basin Salmon Recovery Forum. Everett, WA. Available: https://snohomishcountywa.gov/Archive/ViewFile/Item/4402. Accessed November 2017.
- WDFW (Washington Department of Fish and Wildlife). 2017. Hydraulic Project Approval web page. Available: http://wdfw.wa.gov/licensing/hpa/. Accessed November 2017.





CHAPTER 3. WATERSHED AND LAND COVER CONDITIONS

Duvall is located immediately east of the Snoqualmie River within the lower Snoqualmie River Valley. The 692-square mile lower Snoqualmie River Watershed, and the Skykomish River Watershed to the northeast, make up Water Resource Inventory Area (WRIA) 7. These two rivers converge approximately five miles north of Duvall, forming the Snohomish River, which flows into Puget Sound at Everett.

The 2.5-square mile City is surrounded by unincorporated areas of King County, with agricultural areas and open space floodplain to the south, west, and north, and forested rural lands to the east and southeast. The basins of four small tributaries to the Snoqualmie River are located within or partially within the City and urban growth area (UGA) boundaries: Thayer Creek, Coe-Clemons Creek, Cherry Creek, and Weiss Creek. The City's Watershed Plan further divided these basins into subbasins, representing relatively small catchments where precipitation and groundwater move through natural features and stormwater infrastructure.

This chapter assesses Duvall's basins and subbasins, including consideration of surface waters and other natural resources, geologic conditions, land cover, and known basin alterations. This chapter concludes with identification of prioritized subbasins for surface and stormwater retrofit actions.

3.1 GEOLOGIC CONDITIONS

Geologic conditions are a key element determining how surface water moves through the hydrologic cycle, Figure 3-1. The specific land form and soil conditions affect how much precipitation infiltrates and how much runs off into surface waters. Additional geologic processes such as groundwater aquifer recharge, soil erosion, and landslides are also key geologic considerations related to surface and stormwater management.

According to the report titled *Geohydrology and Ground-Water Quality of East King County* (US Geologic Survey, 1995), the topographic surface of the area surrounding the City is the result of erosion and deposition from the Vashon Stade of the Fraser Glaciation which ended approximately 15,000 years ago. Topography associated with the 1-mile wide

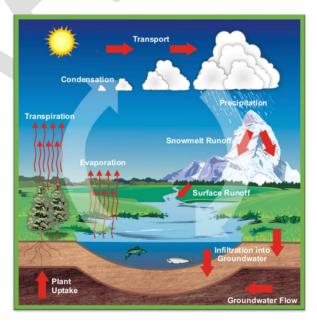


Figure 3-1. Hydrologic Cycle



alluvial valley is a result of more recent erosion and depositional forces associated with the river since deglaciation

Duvall is located on the east valley slope of the lower Snoqualmie River, which flows northward past the community. In general, the City slopes down to the west from an upland plateau at approximately elevation of 500 feet above sea level to the Snoqualmie River floodplain at approximate elevation of 50 feet above sea level.

Approximately 138 acres of the City is located within the Snoqualmie River floodplain; these areas are predominantly City-owned open space and park lands with very little pollution generating impervious surfaces (PGIS). The remainder of the City includes residential, commercial, and undeveloped properties. The western and northern slope of the City transition from Puget Sound lowlands to the foothills of the Cascades.

3.1.1 SOIL CONDITIONS

Mapped soils are consistent with this characterization of the geologic history. According to recent geologic mapping by the Washington State Department of Natural Resources (WSDNR, 2010), soils within the Snoqualmie River floodplain include alluvium (Qa) composed of sand and silt and peat (Qp) deposited since deglaciation (Figure 3-2).

Extremely compacted glacial deposits can be found at the surface east of the Snoqualmie River can be seen in a mapped geologic cross-section located south of the City, which is likely similar to subsurface conditions within the City. Deposits from glaciation and subsequent events occur as layered lenses that outcrop on the surface at different elevations and locations. These deposits sit in relatively thin lenses above older glacial (Pre-Fraser) and nonglacial deposits and bedrock.

The dominant sedimentary deposit in the City east of the Snoqualmie River is Vashon lodgment till (Qgtv), a mixture of clay, silt, sand, and gravel that was deposited beneath, and consolidated by, glaciers as they advanced to the south across the Puget Sound lowlands. At the northern slopes of the City the glacial till is underlain by Vashon advance outwash (Qgav), composed of sand and gravel deposited in meltwater streams and deltas and then consolidated during glacial advance. The glacial till and Advance Outwash are underlain by Advance glaciolacustrine deposits (Qglv), which include silt and clay that were deposited in lakes and other bodies of water in front of advancing Vashon glaciers.

Less common geologic deposits include recessional deposits such as Ice-contact kame deposits (Qgik) with generally higher sand, gravel, and cobble gravel soil that were deposited as the Vashon glaciers receded. Areas along the northern slopes are also mapped as Landslide deposits (Qls) since deglaciation.

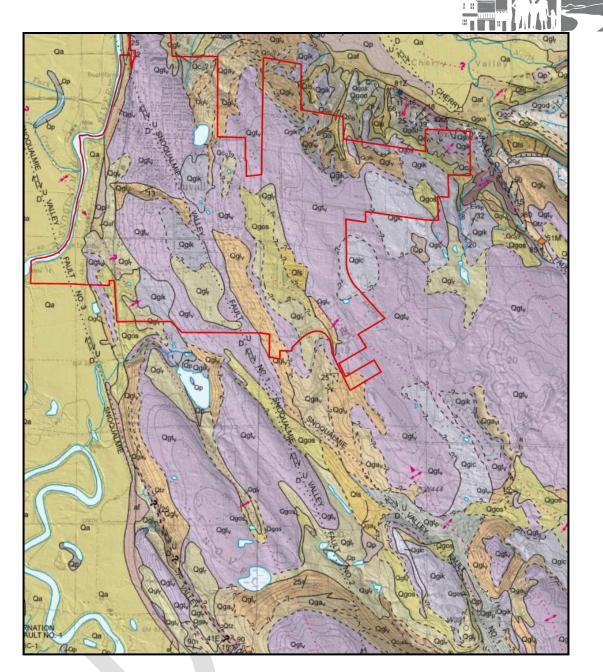


Figure 3-2. Geologic Map with Duvall City limits (in red) and surrounding area; the dominant geologic deposits across Duvall and surrounding areas east of the Snoqualmie River Valley are Vashon lodgment till (Qgtv, extending through purple shaded areas).

According to the Natural Resources Conservation Service (NRCS) soil survey, the dominant surface soil type in the City is Tokul gravelly medial loam. This soil is categorized in Hydrologic Soil Group B, which represents soils with moderate infiltration ability. The soil survey also indicates that this soil group is subject to a relatively shallow soil restrictive layer (NRCS). Previous site-specific studies performed in the City identified porous outwash soil above fractured bedrock and alluvium along major streams, as well as alluvium throughout the floodplains of the Snoqualmie River and Cherry Creek (as cited in City of Duvall, 2015).



3.1.2 EROSION AND LANDSLIDE HAZARDS

Soil erosion is a natural geologic process by which individual soil particles are detached and moved by agents such as wind, rain, frost action, or surface water flows. Mass erosion, such as landslides, is also a natural geologic process. Erosion and movement of sediment through the landscape and within surface waters is an essential process that supports creation of stream, wetland, floodplain and riparian habitats.

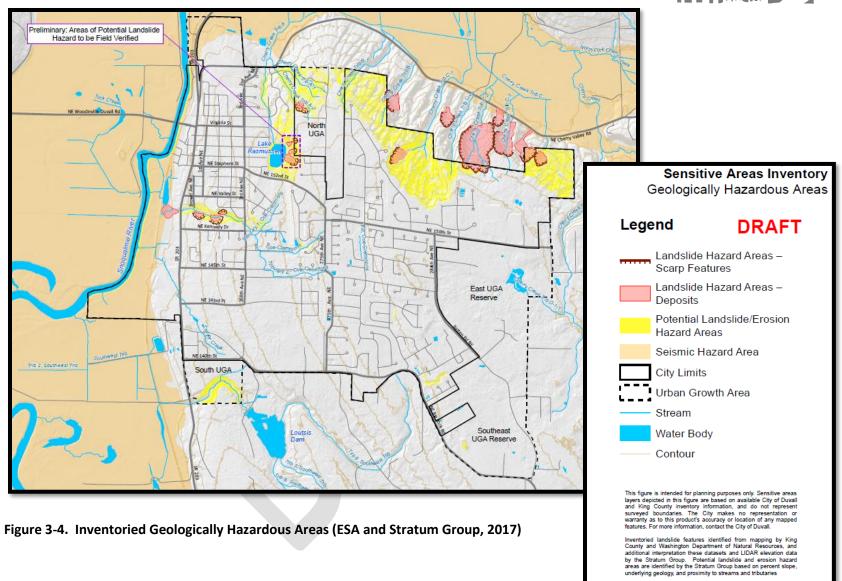
In developed areas, however, erosion can be exacerbated by changes in land cover and concentration of storm runoff. Erosion and landslides adjacent to developed areas can also be a safety hazard. Runoff from impervious surfaces results in concentrated storm flows which in turn can result in excess eroded sediment entering surface waters. Excess eroded sediment can negatively impact ecosystem functions, adding additional fine sediments to stream beds that degrade salmon spawning habitats. Increased stream sediment loads can also plug culverts at road crossings, limiting conveyance capacity, restricting fish passage, and increasing the potential for infrastructure damage during storm events. A recent example of this was the undersized, 6-foot by 6-foot culvert where Coe-Clemmons Creek crosses beneath Main Street, Figure 3-3. The culvert was too small for the size of the stream flow through the culvert was further restricted by increased sediment and debris loads from upstream erosion within Taylor Park until the culvert was replaced in October 2015 with a much larger (25-feet wide by 12-feet high) culvert.



Figure 3-3. 2012 Coe-Clemmons Creek culvert replacement project under SR-203. Inset: Old Coe-Clemmons Creek fish barrier culvert, prior to project.

Recent Sensitive Areas inventory updates completed by the City have identified known landslide hazard areas, and other potential landslide and erosion hazard areas within and surrounding the City (Figure 3-5).







Areas of higher potential for land erosion hazard areas occur within the City, in UGAs, and in surrounding rural areas. The largest concentration on steeper slopes along the northeastern edge of City limits, as well as the Coe-Clemmons Creek ravine.

King County has mapped some areas within and outside of City limits as being prone to landslides (Dragovich et al., 2010; King County, 2015). Additional areas with a history of shallow landslides and inventoried erosion hazards are in Taylor Park where stream incision and stream bank erosion along Coe-Clemmons Creek resulted in recent ravine slope failures. Similar features are present along similar ravine slopes in lower reaches of the Unnamed Southern Tributary to the south of City limits. There are no other significant mapped landslide hazard areas located elsewhere within the City or UGAs.

3.1.3 CONSTRAINTS AND OPPORTUNITIES FOR SURFACE AND STORMWATER MANAGEMENT

Key geologic considerations for stormwater and surface water management include the following:

Limited opportunity for full infiltration LID approaches – Generally, the predominance of relatively low-permeability till soils in Duvall does not support full infiltration BMPs. However, infiltration is feasible in areas of advance outwash and other relatively permeable deposits. These areas have the dominant soil type, Tokul gravelly medial loam, and having adequate depth may accommodate an engineering stormwater design. Experience from project-specific geotechnical explorations suggest that in many areas of the City adequate depths are not available to provide full stormwater infiltration. However, it has been determined by City staff that limited infiltration techniques can be incorporated into stormwater design based on site specific characteristics.

In many areas of the City, the subsurface low permeability glaciolacustrine and till deposits inhibit deeper infiltration from Tokul gravelly medial loam surface soils into the subsurface, and in certain instances may also limit opportunities for underground injection approaches. In several areas of the City infiltrated water is conveyed laterally within shallow advance outwash lenses confined by relatively impermeable till and glaciolacustrine deposits, resulting in springs and seeps emerging on hillslopes and ravines along the northern and western sides of the City. In some locations, the underlying bedrock is likely to be fissured, allowing for deep groundwater recharge at relatively low, variable, infiltration rates.

Erosion potential – Presence of erosive soils and landslide hazard areas heighten the need for effective stormwater flow control approaches and facilities in the Cherry Creek tributary basins and the Coe-Clemons Creek basin. There are several resources that are susceptible to impacts from erosion and sedimentation, including: tributary streams, floodplain habitats, and the mainstem Snoqualmie River.

There are also steep, erosive slopes along the northern edge of the City, and incised streams forming ravines along the western boundary. Excessive water flowing down these slopes can form gullies and increase ravine erosion, which may result in soil wasting, downstream sedimentation, habitat degradation, and infrastructure impacts.



Protection of headwater features – Areas within the City and the associated UGAs have mapped surface soils that include higher amounts of silt, clay, organic silt-clay, and minor peat content. These soil types are generally appropriate for wetland formation. Correlation between geologic mapping of these areas and areas of known depressional wetlands within the upper portions of the City's subbasins has not been reviewed. It remains important to ensure future development maintains soils that could support headwater wetlands. This action will reduce peak flows to downstream channels and provide important habitat and water quality functions.

3.2 CLIMATE

The region has a temperate, maritime climate. Winters are cool and wet, while there is typically a drought period in the summer and early fall. The climate is influenced by Puget Sound to the west and the Cascade Mountains to the east. Average annual precipitation ranges from approximately 30 inches near Puget Sound to 90 inches in the Cascade foothills, with the area surrounding the City averaging 49 inches. Figure 3-5 shows average monthly precipitation as well as low and high temperatures near the City. Most precipitation falls between October and March, where summers typically remain relatively dry. In Duvall and other lowland areas, winter temperatures dip below freezing and snow may occur but are usually of short duration (Franklin and Dyrness 1987).

Runoff processes influencing surface and stormwater systems are a function of the timing and type of rainfall. Well upstream of Duvall in the Cascade Mountains, Snoqualmie River headwater streams receive a large proportion of their total annual runoff from snowmelt. At mid to high elevations within the watershed between 1,500 and 4,500 feet elevation, rain on snow (ROS) events play an important role in runoff. Below approximately 1,500 feet elevation, including the Snoqualmie Valley basins, rainfall is the principal source of precipitation (Brunengo et al. 1992; Solomon and Boles 2002).

Increases in rainfall intensity and altered seasonal precipitation patterns are anticipated within the next several decades due to accelerated climate change. Climate change in the overall Snoqualmie Basin has been modeled extensively by the University of Washington Climate Impact Group and Battelle (CIG and NWFSC 2005; PNNL 2015). Predicted effects include increases in the magnitude of peak flows, changes in the timing of seasonal flow peaks, prolonged and persistent low flows, reductions in summer flows, and increased stream temperatures. These effects would place even greater strain on water quality, threatened salmon populations, drinking water supplies, and flood prone areas.



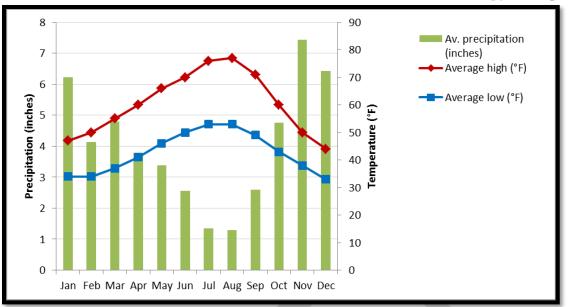


Figure 3-5. Average monthly precipitation and low/high temperatures in the Duvall vicinity.

3.3 LAND COVER

Land cover plays an important role in protecting and maintaining watershed processes. Native vegetation provides habitat, reduces erosion, intercepts runoff, and provides water quality benefits. Additionally, significant trees and tree cover are an important part of the City's rural character. The City has recognized the importance of preserving and replacing trees and other native vegetation in various policy documents, including the KCSWDM, adopted by reference, and the Watershed Plan (City of Duvall, 2015).

3.3.1 HISTORIC CHANGES TO LAND COVER

The hydrology and ecology of the study area have been shaped by historical landscape use. European settlers were drawn to the area starting in the 1870's for its timber resources and used the Snoqualmie River to transport logs downstream to commercial markets. The railroad was constructed in the 1890's on a 12- to 15-foot-tall fill berm that stretched along the eastern edge of the Snoqualmie River, adjacent to the City's modern day Main Street. In the following decades, bridges were constructed over the Snoqualmie River along with roads built on fill berms in the floodplain to connect the area with Lake Sammamish and Lake Washington. The growth of the timber industry and the expanded population brought about rapid changes in vegetative cover and character. These changes included clearing of forest to create agricultural fields and harvesting of old-growth forest and establishment of second-growth forest. Population growth continued through the 1920's, after which the decline of the timber industry in the area minimized the need for laborers.



After the 1920's the pattern of alterations to the Snoqualmie Valley landscape was characterized by clearing native shrubs and riparian vegetation, ditching of streams, land clearing to create pasture, and bank hardening along the Snoqualmie River. In the last 50 years, expanding suburban development from Seattle and Bellevue have led to growth in the City and throughout the Snoqualmie Valley. Agricultural activities are an important component of the economy and land use, with cattle and dairy operations, produce and crop farms, and greenhouse operations extending up and down the Valley. These activities have increased residential housing and associated businesses that have come to characterize the City and other urbanized areas of the watershed.

3.3.2 VEGETATION

Protecting native trees and contiguous forest areas benefits multiple watershed processes, including water flow, water quality, and habitat. All aspects of water flow processes, including delivery, surface storage, recharge, and discharge benefit from increased canopy cover and more mature vegetation. Vegetation improves water quality processes by increasing the opportunity for filtration and reducing the potential for erosion and sedimentation. This is particularly important in sensitive areas such as stream buffers and wetlands.

Riparian vegetation consists of the plants that grow along the margin of streams, lakes, and wetlands. Out of 107 miles of riparian area surveyed in the Snohomish basin, Pentec (1999) found that nearly two-thirds of the riparian vegetation consisted of grass, brush, or sparse trees. The loss of riparian vegetation within the City has impacted salmonid habitat by reducing the food supply for fry, increasing solar heating of the water, and reducing cover and refuge habitat.

3.4 DUVALL BASINS AND SUBBASINS

3.4.1 SURFACE WATERS AND NATURAL RESOURCES

The primary basins making up much of the City and surrounding areas include the: Cherry Creek basin (extending north and northeast of the City), Duvall Tributaries (Coe-Clemmons Creek, Thayer Creek, and an unnamed tributary), and Weiss Creek basin (extending to the south of the City). These basins ultimately drain to the Snoqualmie River.

The City delineated 17 subbasins to more precisely characterize watershed conditions as part of the City of Duvall Watershed Plan (Figure 1-1; City of Duvall, 2015). The current study focuses on those subbasins that include City limits and UGAs. These basins range in size from 98 to 457 acres, varying in forest and impervious surface cover, and generally correspond to first-order streams and specific topographic boundaries as summarized in Table 3-1.

The shape and size of the subbasins are related to the morphology of the subbasin and its drainage pattern. Several subbasins extend outside of City or UGA boundaries. Areas outside of UGA boundaries were included in the Watershed Plan analysis to help understand the connection between actions taken



either inside or outside the City's jurisdiction and watershed processes. The areas outside of City limits are either headwaters or receiving waters. Headwater areas can provide information on the quality or quantity of water coming into the City or UGA, while receiving water areas are impacted by actions occurring within City and UGA boundaries.

For the City's Watershed Characterization, an evaluation of water flow (hydrologic) processes was completed for all subbasins based on the Washington State Department of Ecology's Puget Sound Characterization model (City of Duvall, 2015). Relative importance and degradation of water flow processes were determined for key water flow processes.

Table 3-1. Subbasin Summary

Subbasin Name	Landscape Position	Total Area (acres)	Percent Within City*	Forest Cover (%)	Impervious Surface (%)
Cherry Creek Tributaries Ba	asin				
Cherry Creek Floodplain	Floodplain	865	1%	5%	3%
Cherry Creek A*	Slope / Ravine	264	55%	44%	24%
Cherry Creek B*	Slope / Ravine	158	46%	62%	15%
Cherry Creek C*	Slope / Ravine	457	59%	71%	11%
Cherry Creek D – East	Slope / Ravine	288	< 1%	56%	4%
Cherry Creek D – West	Terrace	166	< 1%	55%	6%
Duvall Tributaries Basin					
Old Town*	Slope / Ravine	146	88%	11%	43%
Coe-Clemons – Lower*	Slope / Ravine	98	100%	27%	43%
Coe-Clemons – Upper*	Terrace	273	100%	26%	43%
Thayer*	Slope / Ravine	235	92%	24%	29%
Coe-Clemons / Thayer Floodplain*	Floodplain	663	13%	7%	3%
Unnamed Southern Tributary – Lower*	Slope / Ravine	373	42%	40%	17%
Unnamed Southern Tributary – South	Slope / Ravine	158	0%	70%	7%
Unnamed Southern Tributary – Upper*	Terrace	327	36%	54%	18%
Weiss Creek Basin					
Weiss Creek – Upper*	Terrace	207	4%	42%	11%
Weiss Creek – Middle	Slope / Ravine	587	0%	54%	8%
Weiss Creek – Lower	Slope / Ravine	1273	0%	63%	7%
			l l		

^{*}Subbasins within the City and associated UGAs are highlighted and shown in **Bold**



3.4.2 CHERRY CREEK BASIN

Cherry Creek is the lowest significant tributary of the Snoqualmie River and the only significant tributary that drains areas of the City. The Cherry Creek watershed covers approximately 32,000 acres, but less than 2% (percent) of the total watershed falls within City and UGA boundaries. Cherry Creek tributaries drain the northeastern portion of the City to the north mainstem creek.

Alterations to the tributaries of Cherry Creek within the City and UGA can impact the high conservation value mainstem and associated floodplain to the north. High to moderate degradation is observed in tributaries A and B, where development is more extensive as summarized in Table 3-2. Tributaries C and D still have low levels of development and many watershed processes are still intact.

Table 3-2. Cherry Creek Subbasin Summary

Subbasin Name	Watershed Plan Management Group	Area (acres)		Impervious Surface within the City (%)			Storm Drainage Area Directed to a Stormwater
		City	UGA	non-PGIS	PGIS	Total	facility (%)
Cherry Creek A	Lowest Conservation (2C)	146	64	15%	15%	30%	80%
Cherry Creek B	Moderate Conservation (2B)	72	23	46%	62%	15%	100%
Cherry Creek C	Highest Conservation (2C)	272	20	59%	71%	11%	100%
Cherry Creek D - West	Highest Conservation (2C)	0.3	129	NA - very	small area	a within	100%

Note: non-PGIS (pollution generation impervious surface) includes walkways/sidewalks, roofs, patios/concrete pads, and decks; PGIS includes roadways, driveways, and parking lots.



Cherry Creek A

Subbasin Cherry Creek A is located on the northern edge of the City, extending through residential areas to the southeast and north of Lake Rasmussen, and north into agricultural areas of King County outside of City jurisdiction. The subbasin also includes the majority of the North UGA, including forested areas, tributary stream channels, and wetlands.

Basin topography slopes generally north down to the Cherry Creek Valley. The southern portion around Lake Rasmussen occurs as a terrace, and slopes increase moving north.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage: Subbasin features provide moderate surface storage during storm events, mostly provided by the man-made, 5.5-acre Lake Rasmussen and depressional wetlands in the upper

Subbasin Characterization			
Acres	264		
Within City	55%		
Within UGA	24%		
Predominant uses	Single-family residential; rural residential and vacant lots in North UGA		
Streams	Cherry Creek Tributary A (flows from Lake Rasmussen), Tributaries A-1 and A-2		
Soils and Geology	Some steep slopes and moderately well drained soils categorized in Hydrologic Soil Group (HSG) B.		
Erosion and Landslide Hazard Areas (within City and UGA)	28% mapped as erosion hazard, extending from Lake Rasmussen to northern City limits, and into North UGA along tributary channels. No mapped landslide hazards.		

portion of subbasin. Lake Storage processes are minimally degraded despite the existing intensity of development within the City, due to retention of existing wetlands and the lake.

Groundwater and Base Flow Maintenance: There are relatively few areas of permeable soils, and higher levels of impervious surface except in the North UGA area that further limit groundwater recharge. Slope wetlands occur around Cherry Creek Tributaries A-1 and A-2 on the forested slopes in the northern portions of the subbasin; however overall there are relatively few features that maintain stream base flows.

Water Quality: Steep slope areas in the northern portion of the subbasin have high export potential for phosphorus and sediment. Runoff from developed areas has likely increased pollutant inputs to subbasin and downstream areas, as well as channel erosion along Cherry Creek Tributary A. Lake Rasmussen and depressional wetlands within the upper subbasin do provide some filtration and sediment deposition for runoff.



Cherry Creek B

Subbasin Cherry Creek B is located on the northern edge of the City, extending through a residential subdivision at Manion Way NE and 277th Place NE construction in 1995-1996, and north into forested, step slope open space areas that extend to City limits. The subbasin also includes the eastern portion of the North UGA, including rural residential and forested properties.

Basin topography slopes generally northeast down to the Cherry Creek Valley, with grade increasing through forested open space areas.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage – This subbasin is of lower importance for surface storage processes and has

Subbasin Characterization			
Acres	158		
Within City	46%		
Within UGA	15%		
Predominant uses within Duvall	Single-family residential, rural residential in North UGA, and vacant lots		
Streams	Cherry Creek Tributary B		
Soils and Geology	Some steep slopes and moderately well drained soils characterized in HSG B.		
Erosion and Landslide Hazard Areas (within City and UGA)	No mapped erosion hazards. 6% mapped as landslide hazard, occurring on forested slopes in the northern portion of the subbasin.		

limited storage opportunity due to steep slopes and lack of wetlands. What surface storage is available is provided by a depressional wetland at the southern edge of the subbasin and is minimally degraded.

Groundwater and Base Flow Maintenance – This subbasin has features that are very important for groundwater recharge and base flow maintenance processes. Permeable soils account for 7% of the subbasin; however, groundwater infiltration is moderately degraded due to higher impervious surface cover within the residential areas. Base flow maintenance processes are likely to be more intact, occurring primarily in forested open space areas.

Water Quality – Potential water quality issues relate to extensive steep slope areas below developed areas with high sediment and phosphorus export potential. The large depressional wetland at the southern edge of the subbasin provides filtration and retains sediment, as do existing stormwater facilities.

Existing stormwater infrastructure (developed in 1995 consistent with 1990 KCSWDM standards) likely provide minimal water quality treatment; but may not fully address water quantity and flow control. Stormwater retrofits and future residential development in the North UGA could provide opportunity to improve water quality and flow control, including potential infiltration approaches.



Cherry Creek C

Subbasin Cherry Creek C covers the northeastern arm of the City, including residential subdivisions on 286th Ave NE and Cedarcrest High School, and extends north into steeply sloped vacant forested areas to City limits, and beyond into forested and rural county residential areas.

Basin topography slopes generally northeast down to the Cherry Creek Valley, with slopes increasing through forested areas.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage – This subbasin is of low importance for surface storage processes due to a predominance of steep slopes and only one percent of the subbasin surface area being occupied by

Subbasin Characterization			
457	Acres		
59%	Within City		
4%	Within UGA		
Single-family residential, Cedarcrest High School, protected open space	Predominant uses within Duvall		
Multiple Cherry Creek Tributary C channels	Streams		
Areas of very steep slopes. Soils can be slowly drained (HSG C) or moderately well drained (HSG B).	Soils and Geology		
20% mapped as erosion hazard and 32% mapped as landslide hazard, occurring on forested slopes in the northern and eastern portions of the subbasin	Erosion and Landslide Hazard Areas (within City and UGA)		

wetlands. Surface storage was historically provided by a depressional wetland at the northern end of the Subbasin, which has been largely degraded by surrounding development.

Groundwater and Base Flow Maintenance – This subbasin is highly important for groundwater recharge processes, with 36% permeable soils that support recharge. Slope wetlands are present in forested areas. Infiltration to groundwater is moderately degraded within the southern portion of the subbasin due to high impervious surface cover; this process remains intact throughout undeveloped areas. Base flow maintenance processes are of lower importance due to the subbasins position in the watershed.

Water Quality – This subbasin has relatively high sediment export potential due to the erodibility of slopes and tributary channels. Extensive steep slopes in the northern subbasin have high export potential for phosphorus and sediment. Recently developed areas (large subdivisions and Cedarcrest High School) likely provide adequate water quality treatment but impact flow quantity and timing.

3.4.3 DUVALL TRIBUTARIES BASIN

The Duvall Tributaries basin covers approximately 2,500 acres within the study area and discharges into the Snoqualmie River. The majority of the associated subbasins are highly developed and watershed processes are heavily degraded. The importance of these subbasins for surface storage, groundwater and base flow, and water quality tends to be low to moderate. Fish and wildlife habitat is moderate to high,



which is primarily due to salmonid use of tributaries that feed into the Snoqualmie River. Only the largely undeveloped Coe Clemons/Thayer Floodplain subbasin retains the majority of watershed processes.

The majority of the subbasins within the Duvall Tributaries Basin are developed, and watershed processes are heavily degraded. Surface storage, groundwater and base flow, and water quality importance tend to be low to moderate. Fish and wildlife habitat is moderate to high, which is primarily due to salmonid use of tributaries that feed into the Snoqualmie River. Only the Coe Clemons / Thayer Floodplain subbasin, located along the western edge of the city and extending into agricultural lands within King County jurisdiction to the south, retains many watershed processes because it is largely undeveloped as summarized in Table 3-3.

Table 3-3. Duvall Tributaries Subbasin Summary

Subbasin Name	Watershed Plan Management Group	Area (acres)		Impervious Surface within the City (%)			Storm Drainage Area Directed to a Stormwater
		City	UGA	non-PGIS	PGIS	Total	facility (%)
Old Town	Urban Development (3)	129	10	18%	23%	41%	29%
Coe-Clemons - Lower	Urban Development (3)	98	0	14%	22%	36%	29%
Coe-Clemons - Upper	Urban Development (3)	273	0	19%	16%	36%	92%
Thayer	Urban Development (3)	215	5	9%	16%	25%	64%
Coe-Clemons / Thayer Floodplain	Protect / Restore (1)	84	0	<0.1%	0.15%	0.15%	98%
Unnamed Southern Tributary - Lower	Lowest Conservation (2C)	156	35	13%	13%	26%	87%
Unnamed Southern Tributary - Upper	Lowest Conservation (2C)	117	19	15%	15%	30%	92%

Note: non-PGIS (pollution generation impervious surface) includes walkways/sidewalks, roofs, patios/concrete pads, and decks; PGIS includes roadways, driveways, and parking lots.



Old Town

The Old Town subbasin is located on the northwestern edge of the City, encompassing historic downtown area. The subbasin is primarily commercial and single family residential with some remnant agricultural land at its northern tip.

Basin topography slopes generally westward to the Snoqualmie River.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage – This subbasin is of low importance for surface storage processes and has limited storage opportunity due to slopes and existing infrastructure and development patterns. The subbasin contains almost no wetlands (0.1%) and previous development has resulted in piped and ditched stormwater conveyance directly to the river.

Subba	sin Characterization
Acres	146
Within City	88%
Within UGA	7%
Predominant uses within Duvall	Commercial
Streams	East bank Snoqualmie River
Soils and Geology	Areas of moderate slopes with moderately well drained soils categorized in HSG B.
Erosion and Landslide Hazard Areas (within City and UGA)	17% mapped as erosion hazard, occurring south of Main St, in the center of the subbasin. No mapped landslide hazards.

Groundwater and Base Flow Maintenance – This subbasin has features that historically, were moderately important for groundwater recharge and base flow maintenance processes. However, these processes have been highly degraded. Permeable soils account for 14% of the subbasin; however, groundwater infiltration is highly degraded due to extensive imperious surface cover and altered flow pathways.

Water Quality – This subbasin is important for water quality due its direct discharge of stormwater to the Snoqualmie River. The subbasin has moderate sediment export potential related to surface erodibility and subbasin slopes. Impervious surface cover and conveyance infrastructure has likely reduced sediment export potential; however, this increases water quality issues related to developed areas.



Coe-Clemmons Lower

The subbasin is located on the western edge of the City, along the southern edge of the Old Town subbasin and includes Taylor and McCormick Parks. The subbasin is primarily single family residential with some commercial areas.

Basin topography slopes generally westward to the Snoqualmie River.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage – This subbasin is of low importance for surface storage processes and has limited storage opportunity due to slopes and existing infrastructure and development patterns. The subbasin contains only 2% wetlands and previous development has resulted in piped and ditched stormwater conveyance directly to the river.

Subbasin Characterization			
Acres	98		
Within City	100%		
Within UGA	0%		
Predominant uses within Duvall	Single-family residential, City park / open space, commercial development along Main Street		
Streams	Coe-Clemmons Creek		
Soils and Geology	Areas of moderate slopes with moderately well drained soils categorized in HSG B.		
Erosion and Landslide Hazard Areas (within City and UGA)	38% mapped as erosion hazard, occurring along steeper slopes of local drainages throughout the subbasin. No mapped landslide hazards.		

Groundwater and Base Flow Maintenance – This subbasin has features that historically were moderately important for groundwater recharge and base flow maintenance processes. However, these processes have been highly degraded. Permeable soils account for 8% of the subbasin; however, groundwater infiltration is highly degraded due to extensive imperious surface cover and altered flow pathways. Base flow maintenance processes are of lower importance due to the subbasin's position in the watershed.

Water Quality – This subbasin is important for water quality due its direct discharge of stormwater to the Snoqualmie River. The subbasin has moderate sediment export potential related to surface erodibility and subbasin slopes. Impervious surface cover and conveyance infrastructure has likely reduced sediment export potential; however, this increases water quality issues related to polluted runoff from developed areas.



Coe-Clemmons Upper

The subbasin is located at the center of the City. Land use is predominantly single family residential.

Basin topography slopes generally westward to the Snoqualmie River. The central portion of the basin is relatively flat, while the eastern and western portions have more pronounced slopes.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage - This subbasin is of moderate importance for surface storage processes and is highly degraded. There is significant opportunity for storage process enhancements through retrofits and other actions. The subbasin contains only 1% wetlands or other surface storage features. Previous development has resulted in piped/ditched

Subba	sin Characterization
Acres	273
Within City	100%
Within UGA	0%
Predominant uses within Duvall	Single-family residential
Streams	Coe-Clemmons Creek and tributary channels
Soils and Geology	Areas of moderate slopes with moderately well drained soils categorized in HSG B.
Erosion and Landslide Hazard Areas (within City and UGA)	12% mapped as erosion hazard. No mapped landslide hazards.

stormwater conveyance with inadequate flow control measures.

Groundwater and Base Flow Maintenance – This subbasin has features that historically, were moderately important for groundwater recharge and base flow maintenance processes. However, these processes have been highly degraded. There are many small slope wetlands along the tributary channels; however, groundwater infiltration is highly degraded due to extensive imperious surface cover and altered flow pathways. Base flow maintenance processes are of lower importance due to the subbasins position in the watershed.

Water Quality – This subbasin is important for water quality due its direct sediment contribution and known erosion issues on Coe-Clemmons Creek. The subbasin has low sediment export potential related to channel erosion and bank stability. Degradation related to impervious runoff has likely increased channel erosion and peak flows downstream. Additionally, urban runoff is likely polluted with metals and other pollutants.



Thayer

The Thayer subbasin is located at the southwestern portion of the City and includes single family residential development, vacant grassy and forested areas, and the Safeway shopping center complex.

Basin topography slopes generally westward to the Snoqualmie River, except for the areas immediately adjacent to Thayer Creek, which drain steeply to the creek. The eastern portion of the basin is relatively flat, while the western portion slopes more steeply towards the river.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage – This subbasin is of low importance for surface storage processes and has limited storage enhancement opportunity due to slopes

Subbasin Characterization			
Acres	235		
Within City	92%		
Within UGA	2%		
Predominant uses within Duvall	High-density single-family residential, rural residential, and commercial		
Streams	Thayer Creek		
Soils and Geology	Areas of moderate slopes with moderately well drained soils categorized in HSG B.		
Erosion and Landslide Hazard Areas (within City and UGA)	12% mapped as erosion hazard, on the steeper slopes draining to Coe-Clemmons Creek. No mapped landslide hazards.		

and existing infrastructure and development patterns. The subbasin contains only 2% wetlands or other surface storage features and previous development has resulted in piped/ditched stormwater conveyance directly to the Snoqualmie river floodplain.

Groundwater and Base Flow Maintenance – The subbasin features are of relatively low importance for groundwater recharge and base flow maintenance processes. The area contains 4% pervious soils and there are small slope wetlands along Big Rock Road. However, groundwater infiltration in the subbasin is degraded due to concentrated imperious surface cover and altered flow pathways.

Water Quality – This subbasin is important for water quality due its direct sediment contribution to lower Thayer Creek and the Snoqualmie River floodplain. The subbasin has moderate sediment export potential related to channel erosion, erodible soils, and channel slopes. Stormwater runoff directed to Thayer Creek affects channel erosion and water quality. Additionally, urban runoff is likely polluted with metals and other pollutants.



Coe-Clemmons / Thayer Floodplain

The Coe-Clemmons and Thayer Floodplain subbasin is located at and to the southwest of the City, with the majority of the subbasin lying outside City boundaries. The subbasin consists primarily of parks and open space immediately adjacent to the Snoqualmie River in the shared floodplain of Thayer Creek, Coe-Clemmons Creek, and the Snoqualmie River.

Basin topography is generally flat, with a minor slope towards the Snoqualmie River. This slope becomes steeper and more pronounced in the western portion of the subbasin.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage - The subbasin is of high importance for surface storage processes, particularly during floods. These processes are significantly degrading

Subbasin Characterization				
Acres	663			
Within City	13%			
Within UGA	0%			
Predominant uses within Duvall	Public park and open space			
Streams	East bank of the Snoqualmie River, Lower Coe-Clemmons and Thayer Creeks, Unnamed southern tributary			
Soils and Geology	Flat slopes with areas of moderately well drained soils (HGS B) and areas of slowly drained soils (HSG C).			
Erosion and Landslide Hazard Areas (within City and UGA)	3% mapped as erosion hazard, along the eastern edge of the subbasin. No mapped landslide hazards.			

due to past and ongoing agricultural uses that resulted in stream and wetland loss. These processes have been partially restored within City limits. The entire subbasin lies in the floodplain and 4% is wetland.

Groundwater and Base Flow Maintenance – This subbasin contains important features for maintaining agricultural and domestic water supplies as well as Snoqualmie River temperatures. The floodplain is 90% pervious soils, and infiltration to groundwater is largely intact due to low levels of impervious surface cover.

Water Quality – The floodplain and wetland landscape supports sediment deposition, water filtration, and shade processes. Although, changes in land use have depleted forest and increased input of pollutants to the subbasin, including metals (from upstream roadway runoff). The Snoqualmie River also experiences elevated water temperatures due to riparian forest loss and tributary impoundment.



Unnamed Southern Tributary Lower

The subbasin is located at the southern portion of the City. The subbasin consists primarily of residential development and undeveloped rural areas to the south of City limits.

The basin topography is a valley, with ridges sloping towards Loutsis Dam Pond from both the east and the west. The topography drains westward towards the Snoqualmie River along the western edge of the subbasin.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage – Subbasin features provide moderate levels of surface storage during storm events, reducing downstream erosion; 6% of the subbasin is comprised of wetlands and other surface

Subbasin Characterization		
Acres	373	
Within City	42%	
Within UGA	9%	
Predominant uses within Duvall	Single family residential and rural residential	
Streams	Lower southern tributary, including Loutsis Dam Pond	
Soils and Geology	Areas of moderate slopes with moderately well drained soils categorized in HSG B.	
Erosion and Landslide Hazard Areas (within City and UGA)	11% mapped as erosion hazard, along the steep slopes draining to the tributary. No mapped landslide hazards.	

storage features (primarily Loutsis Dam pond). Surface storage processes remain largely intact, suggesting importance of maintaining storage into the future.

Groundwater and Base Flow Maintenance – Subbasin features are of relatively low importance to groundwater and base flow maintenance processes. There are no mapped permeable soils, and few mapped slope wetlands; although small slope wetlands likely do occur along the riparian corridors. Processes are minimally degraded due to low levels of existing development and a wide, forested riparian corridor

Water Quality – The subbasin has low sediment export potential; however potential direct sediment contribution to the lowest stream reaches within the ravine upstream of the Snoqualmie River floodplain indicates possible water quality importance. Sediment sources are related to channel erosion, including soil erodibility and channel bank conditions. Sediment sinks occur at Loutsis Dam and other depressional wetlands. Low levels of existing development have left most water quality processes intact. Large areas of impervious surfaces in contributing subbasins have likely increased channel erosion.



Unnamed Southern Tributary Upper

The subbasin is located at the southeastern edge of the City, and straddles City limits. Within the City, the subbasin consists predominantly of residential development, with less developed rural-residential areas lying outside of the UGA boundary.

Basin topography slopes generally westward towards the Snoqualmie River.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage – The subbasin is of low importance for surface storage processes, with only 1% wetlands or other surface storage features. Previous development and filling of wetlands in the northeastern portion of the subbasin (within City limits) has reduced the available storage. The

Subba	Subbasin Characterization							
Acres	327							
Within City	36%							
Within UGA	6%							
Predominant uses within Duvall	Single family residential							
Streams	Upper southern tributary							
Soils and Geology	Areas of moderate slopes with moderately well drained soils categorized in HSG B.							
Erosion and Landslide Hazard Areas (within City and UGA)	10% mapped as erosion hazard, along the southwestern edge of the subbasin. No mapped landslide hazards.							

surface storage that is provided is minimally degraded, especially in areas outside of City.

Groundwater and Base Flow Maintenance – Subbasin features are of relatively low importance to groundwater and base flow maintenance processes. There are no mapped permeable soils and few mapped slope wetlands, although small slope wetlands likely do occur along the riparian corridors. Processes are minimally degraded due to low levels of existing development and a wide, forested riparian corridor

Water Quality – The subbasin has low sediment export potential; however potential direct sediment contribution to the lowest stream reaches within the ravine upstream of the Snoqualmie River floodplain indicates possible water quality importance. Sediment sources include erodible soils and steep slopes. Degradation related to runoff from impervious areas has likely increased channel erosion and peak flows downstream. Additionally, urban runoff is likely to contain metals and other pollutants.

3.4.4 WEISS CREEK BASIN

Weiss Creek discharges into the Snoqualmie River upstream of the City. Most of the basin has low to moderate development and watershed processes are moderately intact as summarized in Table 3-4. Of the 2,169 acres in the basin, only the Upper Weiss Creek subbasin is within the City and UGA boundaries.



Table 3-4. Upper Weiss Creek Subbasin Summary

Subbasin Name Watershed Plan Management Group		Area (acres)		Impervious Surface within the City (%)			Storm Drainage Area Directed to a Stormwater	
		City	UGA	non-PGIS	PGIS	Total	facility (%)	
Upper Weiss Creek	Moderate Conservation (2B)	7	156	2%	9%	11%	4%	

Weiss Creek - Upper

The Upper Weis Creek subbasin is located to the southeast of the City, with the majority of the subbasin lying outside City boundaries. The subbasin is predominantly rural with large areas of forested land. The subbasin is within the existing UGA; any future annexation would increase development pressure, especially along the Big Rock Road and Batten Road corridors.

Basin topography is generally flat, with steeper slopes along the eastern basin boundary.

The following summarizes existing conditions and importance for key processes relevant to surface and stormwater management as summarized from the City of Duvall Watershed Plan (City of Duvall, 2015):

Surface Storage - The subbasin provides a

Subba	sin Characterization
Acres	207
Within City	4%
Within UGA	75%
Predominant uses within Duvall	Rural residential and vacant forest lands
Streams	Headwaters of Weis Creek
Soils and Geology	Areas of moderate slopes with moderately well drained soils categorized in HSG B.
Erosion and Landslide Hazard Areas	No mapped erosion or landslide hazards.

moderate level of surface storage, with 13% of the land area occupied by wetlands or other surface storage features. There is a large, forested, depressional wetland complex within the UGA, to the northeast of Big Rock Ball Fields Park. Surface storage processes are generally intact, as there are low levels of existing development.

Groundwater and Base Flow Maintenance – The subbasin features are moderately important for base flow maintenance processes, but less important for recharge. There are no areas of mapped permeable soils, but large headwater wetlands for Weiss Creek are present. These processes have been minimally degraded, as there are generally low levels of existing development. Low impervious surface cover and high forest cover (especially within wetlands) support groundwater processes.

Water Quality – The headwater landscape of the subbasin supports sediment deposition and water filtration processes. Extensive areas of depressional wetlands suggest that the overall subbasin is a



sediment and phosphorus sink. Wetlands provide water quality filtration before discharge to Weiss Creek. Water quality processes are relatively intact due to low levels of development throughout subbasin, especially areas surrounding the large forested wetland complex.

3.5 TARGET RETROFIT SUBBASINS

Potential Target Retrofit Subbasins were evaluated based on information in this Plan and the City's Watershed Plan (City of Duvall, 2015). The Unnamed Southern Tributary subbasin, Old Town, Coe-Clemmons – Lower, and two subbasins draining to Cherry Creek (the Cherry Creek A and C subbasin) have been identified as potential Target Retrofit Subbasin due to water quality sensitivity, the risk of erosion due to their positions in the watershed, and the presence of listed salmon species. In general, most of these subbasins are characterized by steep slopes, ravines, and large areas of mapped erosive soils and have the following specific characteristics:

- All the project sites are located within areas with relatively high amounts of pollution generating
 impervious surfaces. Water quality LID solutions such as bioswales and vegetated buffers could
 have positive effects on water quality and removal of suspended sediment. Improved storage
 solutions such as ponds and vaults can also reduce peak stormwater runoff volumes and alleviate
 erosion on steep slopes and ravines.
- 2. The Cherry Creek A subbasin also contains Lake Rasmussen, which has been identified as a critical area for sediment and nutrient loading. Projects in this subbasin may help to improve water quality in the lake.
- 3. The Unnamed Southern Tributary subbasins have no mapped permeable soils, and the Cherry Creek A subbasin has very limited permeable soils. These areas are thus poor candidates for infiltration-based LID actions.
- 4. In the Cherry Creek C subbasin 36% of the soils are mapped as permeable with a high potential for groundwater recharge. Depending on the location of the proposed project within the subbasin, this site could potentially be an excellent opportunity for infiltration-based LID. This should be explored in depth using a site-specific feasibility analysis.
- 5. In the Old Town and Coe-Clemmons Lower subbasins have been identified as requiring additional water quality features. Projects in this subbasin may help to improve water quality in the Snoqualmie River.

3.6 CHAPTER 3 REFERENCES

Brunengo, M.J., S. D. Smith, and S. C. Bernath. 1992. Screening for watershed analysis, a GIS-based method for modeling the water input from rain-on-snow storms, for management and regulation of



- clear-cut forest harvest. Unpublished report, Wash. Dept. of Natural Resources, Forest Practices Division. 22 pp.
- US Climate Data, 2016; Figure 3-4: Climatic data averages between 1981 and 2010 from NOAA reported for Monroe, Washington.
- CIG and NWFSC (Climate Impacts Group and NOAA Northwest Fisheries Science Center), 2005. Modeling Climate Change and Land Use Impacts on Salmon Recovery in the Snohomish River Basin. Available from: http://cses.washington.edu/cig/res/ae/snohomish.shtml
- City of Duvall. 2015. City of Duvall Watershed Plan. Prepared for the City of Duvall by ESA. http://www.duvallwa.gov/350/Watershed-Plan
- Dragovich, J.D., H.A. Littke, M.L. Anderson, G.R. Wessel, C.J. Koger, J.H. Saltonstall, J.H MacDonald, S.A. Mahan, S.A. DuFrane. 2010. Geologic map of the Carnation 7.5- minute quadrangle, King County, Washington. Washington Division of Geology and Earth Resources Open File Report 2010-1. Sheet, scale 1: 24,000, with 21 pg text.
- ESA and the Stratum Group. 2017. City of Duvall Sensitive Areas Inventory Geologically Hazardous Areas. Prepared for the City of Duvall. Includes mapping from Dragovich et al. 2010 and King County 2016 Mapping of Potential Landslide Hazards a long King County River Corridors, as interpreted and refined by Stratum Group.
- Franklin, J. F. and C. T. Dyrness. 1987. Natural Vegetation of Oregon and Washington. Oregon State University Press.
- King County. 2015. Results of a Preliminary Landslide Investigation in King County, Washington, Phase 1. Prepared by River and Floodplain Management Section; Water and Land Resources Division; Department of Natural Resources and Parks in collaboration with Department of Permitting and Environmental Review. Seattle, Washington. Natural Resources Conservation Service (NRCS), United States Department of Agriculture, Web Soil Survey https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
- PNNL (Pacific Northwest National Laboratory), 2015. Estuarine response to river flow and sea-level rise under future climate change and human development. Estuarine, Coastal and Shelf Science 156:19-30.
- Solomon, F., and M. Boles. 2002. An Overview of the Geology and Geomorphology of the Snoqualmie River Watershed. November. King County DNRP. Available at: http://green.kingcounty.gov/WLR/Waterres/StreamsData/reports/snoqualmie_cond_2001.aspx.
- Stanley, S., S. Grigsby, T. Hruby, and P. Olson. 2009. Puget Sound Watershed Characterization Project: Description of Methods, Models and Analysis. Washington State Department of Ecology. Publication #10-06-005. Olympia, WA.
- US Climate Data. 2016. Website Climate Data Averages for Monroe, Washington Vicinity from United States Weather Service. Accessed December 2016. Available: https://www.usclimatedata.com/
- U.S. Geological Survey. 1995. Geohydrology and Ground-Water Quality of East King County. Prepared by G.L. Turney, S.C. Kahle, and N.P. Dion. Water-Resources Investigations Report 94-4082.
- Washington State Department of Natural Resources. 2010. Geologic Map of the Carnation 7.5-minute Quadrangle, King County, Washington. Prepared by Joe D. Dragovich, Heather A. Littke, Megan L. Anderson, Gregory R. Wessel, Curtis J. Koger, Jennifer H. Saltonstall, James H. MacDonald Jr., Shannon A. Mahan, and S. Andrew DuFrane.



CHAPTER 4. SURFACE AND STORMWATER SYSTEM DESCRIPTION

4.1 Overview of Stormwater Infrastructure

The City's diverse stormwater infrastructure is characteristic of its transformation from a small, riverfront, logging town into a growing, modern, city. Flow control and water quality facilities are largely nonexistent in the heart of Old Town residential neighborhoods. However, additions of LID BMPs are required with new and re-development activities.

The information presented in this chapter was derived from Geographic Information Systems (GIS) facility analysis and inventory performed by Public Works staff (Duvall, 2017). This analysis represents the best available data on the City's stormwater system.

4.1.1 FACTORS ANALYZED

Facilities

In 2017, a total of 170 public and privately-owned stormwater facilities were identified within the City. As a NPDES Permit requirement, these facilities are reported on an annual basis to Ecology. Table 4-1 shows the facility distribution by type and ownership.

Table 4-1. Facilities by Type

Thomas -	0wn	2018 Average	
Туре	Public	Private	Unit Cost (\$) \$
Bioswale / bioretention	38	2	
Detention Pipe	32	7	
StormFilter	13	11	
Pond	29	4	
Vault	20	9	
Other (OWS structures, infiltration, etc.)	2	3	
Totals	134	36	
Totals		170	

Bioswales, including bioretention areas (typically paired with detention vaults or ponds to provide additional water quality function), and detention pipes are the most common facility types in the City, followed by ponds, vaults, and stormfilters respectively. As discussed in Chapter 3, the relatively low



infiltration capacity of the glacial soils within the City limits locations where full infiltration techniques will operate effectively.

City staff determined that an important factor for assessing the effectiveness of stormwater infrastructure is the edition of the KCSWDM used to design the facility. As the science has improved, the effectiveness of stormwater facilities has also improved. Stormwater facilities designed to more recent standards will provide more effective flow control and water quality treatment, increasing protection of sensitive areas and downstream systems. For example, the 1998 KCSWDM provides a higher standard of flow detention and treatment than previous manuals, whereas the most recent (2005, 2009, and 2016) manuals are even better still. Table 4-2 shows the facility distribution by design basis.

Table 4-2. Facilities by Design Basis

Design Manual	Percent (%)			
Pre-1998 KCSWDM	44%			
1998 KCSWDM	31%			
2005 KCSWDM	9%			
2009 KCSWDM	15%			
2016 KCSWDM	No constructed facilities as			
	of November 2017			

The largest percentage by category is for facilities based on the pre-1998 KCSWDMs, however, that is shifting as newer facilities come online, and older facilities are retrofitted. These facility design dates strongly reflect trends in the housing market with spikes in the early 1990's and the early to mid-2000's.

Detention and Water Quality

The detention and water quality volumes for existing stormwater facilities was some of the hardest information to gather, with little to no data available for approximately 40% of the inventoried facilities. Consequently, while the data presented is the best available and is believed to be representative, it should be regarded as an estimate. For these calculations, Total Volume refers to the total amount of stormwater that a facility can store, while Water Quality Volume is the amount of that storage that provides water quality benefits. For example, in a bioswale, 100% of the available storage would be expected to provide water quality benefits, while in a detention pond or a vault, the percentage would be much lower and would depend on the design of the individual facility. Currently, there is over two million cubic feet of known detention volume in the study area, 20% of which also provides water quality benefits by design. Some facility types (such as ponds) may provide incidental water quality benefits even if they are not specifically designed to do so.

Catch Basins

There are over 2,500 mapped public and privately-owned stormwater structures (inlets for water to enter the stormwater system) in the City, for an average density of 2.8 catch basins per developed acre. Catch



basin density can be an important metric because it serves as an indication of how far runoff will have to travel before finding its way into the stormwater system. The longer runoff travels before entering the stormwater system, the more opportunities there are to cause erosion or collect pollutants. Table 4-3 details the types of catch basins in Duvall by type.

Table 4-3. Catch Basins by Type

Туре	Count	Percent (%)
Cleanout	96	4
Oil - water separator	4	0.1
Type 1	1894	70
Type 1-L	69	3
Type 2	536	20
Vault access manhole	60	2
Yard drain	31	1
Total	2691	100

A Type 1 catch basin has a metal lid (solid or grated) set flush with the ground surface and covering a rectangular concrete box up to five feet deep. These are used to convey water into pipes less than 18 inches in diameter and within five feet of the surface. They are the most common type of stormwater catch basin in the City and widely used nationwide.

A Type 2 catch basin has either a solid or a grated cover. These are used to connect to larger pipes or when the depth from the ground surface to the pipe is greater than five feet. These structures are also used as control structures or flow splitters to manage discharge flow rates from facilities. It is the second most common type of catch basin in the City and widely used nationwide. Conveyance

There are more than 60 miles of mapped stormwater conveyance in the study area, including approximately 172 mapped culverts (includes driveway crossings) and 2.5 miles of natural stream mapped as part of the stormwater conveyance system.

Pipes are by far the most common type of conveyance in the City, as in most cities, as seen in Table 4-4. Pipes are effective, safe, out of sight, have a long service life, and are the right design choice for many situations. However, most conveyance pipes are not designed to provide detention, and they do not provide water quality or ecological benefits. Consequently, it is important to pair pipes with stormwater facilities that provide these benefits.



Table 4-4. Conveyance by Type

Typo	Count	Total	Percent (%)	Percent (%)
Туре	(Segment)	Length (Ft)	by Length	by Count
Artificial Stream	2	336	0.1	0.05
Culvert	172	7,902	2	4
Detention Pipe	51	4,738	1	1
Ditch	264	39,910	12	6
French Drain	34	4,115	1	1
Infiltration Trench	27	1,644	0.5	1
Pipe	2,953	220,240	66	67
Natural Stream	52	13,548	4	1
Yard Drain	879	38,860	12	20
Total	4,434	331,295	100	100

4.2 ASSET MANAGEMENT

In addition to planning for regular operations and maintenance of the system (described in more detail in Chapter 8) the City must also budget and plan for regular replacement cycles as stormwater system components reach the end of their functional lives. Different components of the system have different service lives, and may last longer or shorter depending on how they were constructed and how they are being used. Table 4-5 shows the WSDOT (2017) minimum design service life for different system components. This the minimum amount of time that a well-designed and properly installed and maintained component should be expected to last.

Table 4-5. Recommended Component Service Life (WSDOT 2017)

Component	Service Life (years)			
Conveyance Pipe	50 - 80			
Drain Pipe	25			
Manhole	50			
Catch Basin	30			
Roadside Ditch	15			
Culvert	50 - 75			

The City is fortunate to have a relatively new stormwater system in most parts of the City. As part of the planning process, the Public Works Department has been compiling information on the age and types of different components of the system. This process is still ongoing, so it is likely that some of the components with unknown installation dates listed will still be identified. Facilities in parts of Old Town,



are likely to be older and designed to less stringent requirements. Private systems are also listed, even though they are not technically the City's fiscal responsibility.

Table 4-6. Linear feet of Public Conveyance by Age (as of January 2018)

	Unknown	≤ 10 yrs	11 - 20 yrs	21-30 yrs	30 - 40 yrs	Average 2018 Unit Cost
Culvert	2,002	832	4,101	289	564	
Pipe	27,846	16,842	68,740	59,627	12,652	
Ditch	18,949	6,451	11,201	1,381	124	
Drain	0	0	718	0	67	
Infiltration Trench	192	0	572	0	0	

Table 4-7. Linear feet of Private Conveyance by Age (as of January 2018)

	Unknown	≤ 10 yrs	11 - 20 yrs	21-30 yrs	30 - 40 yrs	Average 2018 Unit Cost
Culvert	16	99	0	0	0	
Pipe	12,156	5,963	19,690	1,263	199	
Ditch	549	0	1255	0	0	
Drain	9,097	1,814	13,570	16,766	941	
Infiltration Trench	289	223	367	0	0	

Table 4-8. Count of Public Catchments by Age (as of January 2018)

	Unknown	≤ 10 yrs	11 - 20 yrs	21 - 30 yrs	30 - 40 yrs	Average 2018 Unit Cost
Cleanout	1	0	1	0	0	
Oil - water separator	0	0	0	0	0	
Type 1 & 1-L	1,679	182	803	395	118	
Type 2	450	78	224	116	22	
Manhole	31	4	22	0	0	
Yard drain	2	0	0	0	1	



Table 4-9. Count of Private Catchments by Age (as of January 2018)

	Unknown	< =10 yrs	11 - 20 yrs	21-30 yrs	30 - 40 yrs	Average 2018 Unit Cost
Cleanout	28	6	59	6	0	
Oil - water separator	1	1	2	0	0	
Type 1 & 1-L	43	48	151	45	1	
Type 2	9	9	61	4	3	
Manhole	0	4	25	0	0	
Yard drain	5	11	12	1	0	

4.3 STORMWATER FLOW CONTROL AND WATER QUALITY TREATMENT FACILITIES

This section discusses existing stormwater infrastructure by subbasin. The stormwater facility distribution shown in Table 4-5 reflects the broader pattern of development within the City. Older areas are less likely to be served by a stormwater facility. INSERT MAP

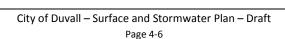




Table 4-10. Subbasin Summary

Subbasin	Developed Area* (Acres)	Total Area in City & UGA (Acres)	Developed Area* Served by a Facility (%)	Facility Count	Average Development Year
Cherry Creek A	100	215	81%	19	2000
Cherry Creek B	50	76	96%	7	2000
Cherry Creek C	143	268	100%	16	2001
Coe-Clemmons - Lower	74	99	31%	12	1990
Coe-Clemmons - Upper	196	212	94%	36	1998
Coe-Clemmons / Thayer Floodplain	9	94	79%	6	1998
Old-Town	104	136	26%	25	2003
Thayer	71	315	77%	22	2002
Unnamed Southern Tributary - Lower	126	166	100%	11	1997
Unnamed Southern Tributary - Upper	99	108	78%	13	1995
Upper Weiss Creek	5	123	94%	3	Unknown

^{*} Developed area was approximated as any area within a subdivision that does not include: wetlands, stream buffers, landslide hazard areas, or designated open space.

4.3.1 CHERRY CREEK BASIN

The Cherry Creek tributaries drain the northern edge of the City and the North UGA. The large-scale transition of this area from primarily rural-residential development and forest land to residential subdivision started in the early 1990's and continues to the present. The three subbasins are very similar in percent coverage and age of development.

Cherry Creek A

Facilities – There are 19 stormwater facilities in the Cherry Creek A subbasin, which were constructed between 1989 and 2016, with an average construction year of 2000. Approximately 81% of the developed area is classified as both developed and served by a stormwater facility. Facility types are primarily bioswales, detention pipes, ponds, and vaults, with stormfilters being less common. The majority were designed using the 1998 KCSWDM with the remainder based on the pre-1998 KCSWDM, 2005 KCSWDM, and 2009 KCSWDM.

Detention and Water Quality – Approximately 32% of the known storage volume in the watershed provides water quality benefits.



Catch basins – There are approximately 308 mapped catch basins in the Cherry Creek A subbasin, for a density of 3.1 catch basins per developed acre. Most of these catch basins are Type 1 and Type 2.

Conveyance – There are 34 mapped culverts and approximately eight miles of conveyance in the Cherry Creek A subbasin. Most of this conveyance is pipes and ditches. The subbasin also contains 3,470 feet of natural stream and 342 feet of infiltration/dispersion trench.

Cherry Creek B

Facilities – There are 7 stormwater facilities in the Cherry Creek B subbasin that were constructed in 1994 or 2005, with an average construction year of 2000. Approximately 96% of the developed area is served by a stormwater facility. Facility types are primarily bioswales, detention pipes, and vaults, with stormfilters and ponds being less common. Over half were designed using the 1998 KCSWDM and the rest using the pre-1998 KCSWDM.

Detention and Water Quality – Only 7% of the known storage volume in the watershed provides water quality benefits.

Catch basins – There are approximately 84 mapped catch basins in the Cherry Creek B subbasin, for a density of 1.7 catch basins per developed acre. Most of the catch basins are Type 1 or Type 2.

Conveyance – There are no mapped culverts and approximately two miles of conveyance pipe in the Cherry Creek B subbasin. There are no natural or artificial streams mapped as part of the stormwater conveyance.

Cherry Creek C

Facilities – There are 16 stormwater facilities in the Cherry Creek C subbasin that were constructed between 1992 and 2016, with an average construction year of 2001. Approximately 100% of the developed area is served by a stormwater facility. Facility types are primarily bioswales, detention pipes, and vaults, with stormfilters, infiltration or dispersion trenches, and ponds being less common options. The majority were designed using a pre-1998 KCSWDM and the remainder using the 2005 and 2009 KCSWDM.

Detention and Water Quality – Approximately 16% of the known storage volume in the watershed provides water quality benefits.

Catch basins – There are approximately 405 mapped catch basins in the Cherry Creek C subbasin, for a density of 2.8 catch basins per developed acre. Most catch basins are Type 1 or Type 2.

Conveyance – There are 13 mapped culverts and approximately nine miles of conveyance pipe in the Cherry Creek C subbasin. The subbasin also contains 415 feet of infiltration or dispersion trench. There are no natural stream channels mapped as part of the stormwater conveyance.



4.3.2 DUVALL TRIBUTARIES BASIN

The Tributaries Basin covers the oldest and most developed portions of the City including the lowland areas and floodplain of the Snoqualmie River. Since much of this area was developed before stormwater collection and treatment was common, there tend to be no stormwater facilities.

Old Town

Facilities – There are 25 stormwater facilities in the Old Town subbasin that were constructed between 1989 and 2014, with an average construction year of 2003. These facilities are largely clustered in Old Town and are privately-owned facilities serving commercial properties. Only 26% of the developed area is served by a stormwater facility, reflecting the area's age and history. Facility types are primarily stormfilters and detention pipes, with bioswales, ponds, vaults, and infiltration/dispersion trenches being less common options. Design basis is evenly split among all the KCSWDMs with no period having prevalence.

Detention and Water Quality – Approximately 54% of the known storage volume in the watershed provides water quality benefits, the highest of any subbasin in the City.

Catch basins – There are approximately 322 mapped catch basins in the subbasin, for a density of 3.1 catch basins per developed acre. Most of these catch basins are Type 1.

Conveyance – There are 32 mapped culverts and approximately six miles of conveyance in the subbasin, most of which conveys flows from other parts of the City. Most of this conveyance is piped with the remainder being open ditch. This subbasin also contains 39 feet of infiltration or dispersion trench.

Coe-Clemmons Lower

Facilities – There are 12 stormwater facilities in the relatively small Coe-Clemmons Lower subbasin that were constructed between 1987 and 2002, with an average construction year of 1990. Only 31% of the developed area is served by a stormwater facility, reflecting the area's age and history. Facility types are primarily detention pipes, with bioswales, ponds, and vaults being less common options. All but one of the facilities were designed based on a pre-1998 KCSWDM.

Detention and Water Quality – None of the known storage in this subbasin is designed to provide water quality benefits.

Catch basins – There are approximately 112 mapped catch basins in the subbasin, for a density of 1.5 catch basins per developed acre. Most of these catch basins are Type 1.

Conveyance – There are 31 mapped culverts and approximately five miles of conveyance in the subbasin. Most of this conveyance is pipes and ditches. The subbasin contains 3,900 feet of natural stream.



Coe-Clemmons Upper

Facilities – There are 36 stormwater facilities in the Coe-Clemmons Upper subbasin that were constructed between 1988 and 2012, with an average construction year of 1998. Approximately 94% of the developed area is served by a stormwater facility. Facility types are primarily bioswales, detention pipes, and ponds with vaults being a less common option. This subbasin also contains the only energy dissipaters in the system. Most of the facilities were designed based on the 1998 or a pre-1998 KCSWDM. The remainder are split between the 2005 or 2009 KCSWDM.

Detention and Water Quality – Approximately 21% of the known storage volume in the watershed provides water quality benefits.

Catch basins – There are approximately 566 mapped catch basins in the subbasin, for a density of 2.9 catch basins per developed acre. Most of these catch basins are Type 1 or Type 2.

Conveyance – There are 21 mapped culverts and approximately 12 miles of conveyance in the subbasin. Most of this conveyance is pipes and ditches. The subbasin contains 4,360 feet of natural stream.

Thayer

Facilities – There are 22 stormwater facilities in the Thayer subbasin that were constructed between 1998 and 2009, with an average construction year of 2002. Approximately 77% of the developed area is served by a stormwater facility. Facility types are primarily bioswales and vaults with detention pipes, stormfilters, infiltration or dispersion trenches, and ponds being less common options. The design basis for these facilities is evenly split between the pre-1998, 1998, and 2009 KCSWDMs, plus a few facilities based on the 2005 KCSWDM.

Detention and Water Quality – Approximately 24% of the known storage volume in the watershed provides water quality benefits.

Catch basins – There are approximately 334 mapped catch basins in the subbasin, for a density of 4.7 catch basins per developed acre – some of the densest coverage in the City, largely due to newer shopping complexes. Most of these catch basins are Type 1 or Type 2.

Conveyance – There are 29 mapped culverts and approximately seven miles of conveyance in the subbasin. Most of this conveyance is pipes and ditches. The subbasin contains 3,550 feet of natural stream and 650 feet of infiltration/dispersion trench.

Coe-Clemmons / Thayer Floodplain

Facilities — There are 6 stormwater facilities in the very small and largely undeveloped (and undevelopable) Coe-Clemmons/Thayer Floodplain subbasin. These facilities were constructed between 1991 and 2003, with an average construction year of 1998. Approximately 79% of the developed area is served by a stormwater facility. Facility types are primarily detention pipes with bioswales and stormfilters



being less common options. Most of the facilities were designed based the 1998 KCSWDM, with a couple using an earlier guidance manual or method.

Detention and Water Quality – None of the known storage in this subbasin is designed to provide water quality benefits.

Catch basins – There are approximately 43 mapped catch basins in the subbasin, for a density of 4.9 catch basins per developed acre. Most of these catch basins are Type 1 or Type 2.

Conveyance – There are 4 mapped culverts and approximately one mile of conveyance in the subbasin. Most of this conveyance is pipes and natural stream. The subbasin contains 1,800 feet of natural stream.

Unnamed Southern Tributary Lower

Facilities – There are 11 stormwater facilities in the Unnamed Southern Tributary Lower subbasin. These facilities were constructed between 1985 and 2011, with an average construction year of 1997. Approximately 100% of the developed area is served by a stormwater facility. Facility types are evenly split between bioswales, detention pipes, ponds, and vaults with stormfilters being a less common options. Most of the facilities were designed based on a pre-1998 KCSWDM with all but one of the rest using the 1998 KCSWDM.

Detention and Water Quality – Approximately 18% of the known storage volume in the watershed provides water quality benefits.

Catch basins – There are approximately 299 mapped catch basins in the subbasin, for a density of 2.4 catch basins per developed acre. Most of these catch basins are Type 1 or Type 2.

Conveyance – There are three mapped culverts and approximately six miles of conveyance in the subbasin. Most of this conveyance is pipes. The subbasin contains no infiltration/dispersion trenches or natural streams mapped as stormwater conveyance.

Unnamed Southern Tributary Upper

Facilities – There are 13 stormwater facilities in the Unnamed Southern Tributary Upper subbasin. These facilities were constructed between 1989 and 2005, with an average construction year of 1995. Approximately 78% of the developed area is served by a stormwater facility. Facility types are primarily detention pipes with bioswales and ponds being less common options. Most of the facilities were designed based on a pre-1998 KCSWDM with the rest using the 1998 KCSWDM.

Detention and Water Quality – Only 2% of the known storage volume in the watershed provides water quality benefits.

Catch basins – There are approximately 214 mapped catch basins in the subbasin, for a density of 2.2 catch basins per developed acre. Most of these catch basins are Type 1 or Type 2.



Conveyance – There are five mapped culverts and approximately four miles of conveyance in the subbasin. Most of this conveyance is pipes or ditches. The subbasin contains 198 feet of infiltration/dispersion trench.

4.3.3 Weiss Creek Basin

The Weiss Creek basin is located to the southeast of the City, with most of the basin lying outside of City boundaries. Only a very small area of developed land lies within this basin – a portion of Big Rock Ball Fields Park.

Weiss Creek - Upper

Facilities – There are three inventoried stormwater facility in the Upper Weiss Creek subbasin, covering 94% of the area classified as developed. These are pond facilities, but the date of construction and design basis are not known.

Detention and Water Quality – The attributes of these facilities are not known.

Catch basins – There are four catch basins in the subbasin, for a density of 0.7 catch basins per developed acre – the lowest in the city. Three catch basins are Type 2 and one Type 1.

Conveyance – There are no mapped culverts and approximately 782 linear feet of conveyance in the subbasin. Most of this conveyance is ditches and pipes.

4.4 Drainage, Erosion and Water Quality Concerns

The following section provides areas of known drainage, erosion and/or water quality concerns within the City's surface and stormwater drainage network. For the most part, these areas have been identified through maintenance activities, citizen complaints, and storm incident response documentation.

- Duvall Mobile Home Park
- Cedarcrest High School Athletic Fields and Parking Areas
- Big Rock Road NE
- Cherry Valley Vista (NE Rupard Road)
- 3rd Avenue NE Corridor
- Legacy Ridge (NE 286th Avenue culvert)
- Juniper Glen (neighborhood ditch conveyance)
- 4th Avenue Apartments (a.k.a. The Park Apartments outfall)
- NE Kennedy Drive Corridor



Public Works has also implemented several capital projects in the last decade to address concerns within other subbasins at specific storm drainage catchments. These projects and the underlying concerns addressed are documented in Chapter 2, and include several stormwater pond retrofit activities in the Coe-Clemmons Upper subbasin and the Unnamed Southern Tributary Upper subbasin.

4.5 CHAPTER 4 REFERENCES

The information presented in this chapter was derived from GIS facility analysis and inventory performed by Public Works staff and the project team for this project effort.

Additional reference:

WSDOT. 2017. Hydraulics Manual (M23-03.05). http://www.wsdot.wa.gov/Publications/Manuals/M23-03.htm





CHAPTER 5. SYSTEM ANALYSIS

5.1 Systems Analysis and Priority Project Identification Methods

There are approximately 170 mapped stormwater facilities within the City, including many multi-structure facilities. As such, it was not feasible to visit each one to conduct a field analysis. Instead, Public Works developed and implemented an innovative approach to assess and prioritize drainage areas (organized as drainage plats) across the City and urban growth areas (UGAs). For this Plan, all assessment relies on the City's geodatabase of existing stormwater conveyance infrastructure, including: type, size, outfall location, and design parameters at the time of development (as well as identification of areas without water quality or detention facilities).

Geodatabase characteristics were considered at the drainage plat level along with detailed mapping of tree canopy cover and impervious surface coverage. City staff used these parameters to establish an assessment and ranking tool to identify stormwater retrofit opportunities across the City. Each facility and associated drainage plat area was assigned a score based on:

- Facility features:
 - Facility type
 - Design basis (adopted design manual used)
 - Outfall location
- Drainage area features:
 - o Tree cover
 - Impervious surface coverage
- Watershed features:
 - Susceptibility to erosion
 - Sensitivity of downstream waters

Assigning scores to each of the factors resulted in a facility rank in each of three categories: Opportunity, Performance, and Downstream Water. **Error! Reference source not found.** conceptually highlights the overall assessment and ranking structure (see Appendix XX for details on assessment and ranking methodology).

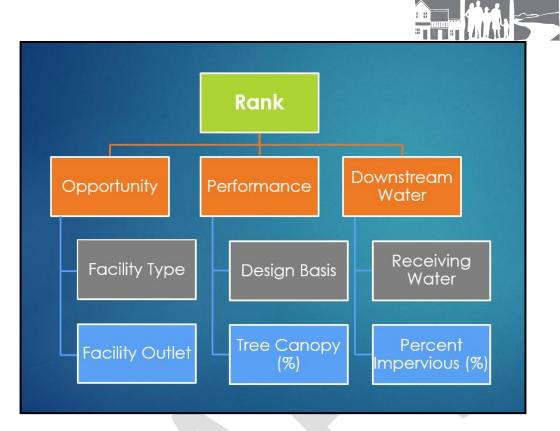


Figure 5-1. A diagram outlining the facility assessment and ranking process including the factors in each scoring category.

The higher the aggregate score, the higher the facility (and associated drainage plat) ranked for retrofit. Drainage plat areas within the City that are not currently served by a facility were also ranked, but in a separate list that does not include the Opportunity scoring component. Separate scoring and ranking of drainage plats with no facility recognize the additional cost and complexity of installing new facilities in an area where one does not exist.

For all drainage plats with existing facilities, the top-ranked projects were then reviewed by the project team and assessed on more site-specific factors. These factors include additional considerations for:

- Private/Public partnership potential
- Ownership
- Known facility deficiencies "hot spots"
- Site specific information regarding retrofit ease/difficulty (available area, existing grade, etc.)
- Potential to implement Low Impact Development (green stormwater) solutions
- Upstream or downstream retrofit opportunity

The final list of projects recommended for retrofit reflects both the ranking process, additional filters for feasibility, and the professional judgement of City staff.



5.2 RETROFIT OPTIONS

The goal of any retrofit project is to improve the performance of the existing facility. In this context, improvement is measured in reductions in peak flows (improved detention) and reductions in pollutants (improved water quality). The specific pollutants that need to be addressed vary by location. Water quality testing should be conducted at each proposed retrofit site so that the system can be designed to best address the prevailing water quality issues. Common water quality issues include total suspended solids (TSS), heavy metals, oil and grease, and biological matter.

This section provides general identification of the suite of retrofit approaches that could be used to address identified storm and surface water impairments. Each of the specific actions that have been considered for stormwater retrofit projects rely on these general retrofit approaches. Along with traditional stormwater facility retrofit actions, green-stormwater infrastructure (GSI) and LID actions will be identified, as well as discussion of actions that could combine traditional and GSI/LID approaches

5.2.1 REDUCING PEAK FLOWS

Reducing peak flows to downstream receiving waters generally involves use of BMPs to either reduce runoff from a drainage area, or delay the arriving inflows. Reduction in flow is generally accomplished by increasing infiltration to the groundwater table, while delay of flow is generally accomplished by providing additional storage or reconfiguring the facility's outfall to release storage more slowly.

Maximizing Infiltration

As discussed in Chapter 3, infiltration is not a widely applicable solution in the till soils of the City. However, permeable soils are present in some areas, and depending on results of site-specific investigation, it may be feasible to design infiltration facilities at these locations. For sites located within mapped areas of permeable soils, it is recommended to conduct infiltration tests to verify that the soils have the appropriate characteristics for infiltration as well as any available groundwater mapping. This will assess if the infiltrated stormwater will just reappear as a spring further downslope, resulting in adverse drainage problems for adjacent properties (whether developed or natural).

Another alternative to a traditional infiltration system is to change the characteristics of the contributing drainage area from impervious to pervious surface coverage. Impervious surfaces such as roofs, driveways, and roadways, increase runoff concentrations as opposed to soaking into vegetated areas. For example, replacing a paved pathway with woodchips, gravel, pavers, grasscrete, or some other pervious material would allow more runoff to soak in rather than flow into a conveyance system. For many areas of the City, implementing retrofits that separate 'clean' runoff from pollution generating impervious surfaces would allow for a more beneficial focus of resources.

Amending soils to increase infiltrative capacity, and increasing vegetative cover across a site, are additional strategies to maximize pervious surfaces. Planting trees or retaining and shrubs can help reduce



total runoff, especially if providing canopy and root structures in areas of restored soils converted from hardscapes. Additionally, for single family residential homes, LID solutions like rain barrels and cisterns can have dual benefits of reducing both winter runoff and summer domestic water demand by allowing homeowners to store runoff on their properties for use on their lawns and gardens.

New or Expanded Detention

The concept of stormwater detention has been around for a long time and is generally well understood. By capturing runoff during a storm's peak rainfall intensity, and releasing it over a longer period, you can reduce downstream flow impacts including flooding and erosion. This approach also leads to a more natural stream hydrograph, maintaining aquatic habitat conditions beneficial to native fish species, including salmonids. Increasing detention time generally involves enlarging a facility to add additional storage capacity, but can sometimes be accomplished more economically by reconfiguring an outlet control structure.

There are several stormwater models to determine detention requirements in a basin, including the Washington Department of Ecology's Western Washington Hydrologic Model (WWHM). These models are frequently required for new construction but can also be applied to retrofit studies. Other ways to assess if more detention is required in a basin is to monitor existing facilities and look for downstream impacts. If an existing facility reaches its storage capacity and overflows frequently during rainfall events, it is a candidate for expansion. Evidence of bank erosion in an otherwise healthy channel or reports of downstream flooding during storms are also indicators of a need for additional storage upstream.

After determining that there is a need for additional detention in the subbasin, sites should be assessed for feasibility such as site layout and facility type. The site layout determines if there is space available to make the proposed modifications, and how it should be designed. For example, at a wide-open site it may be possible to add a new pond or expand an existing one, while in a more constrained location, underground facilities might be a better option. Facility type affects the ease of construction. It is much easier to add capacity to a pond rather than modify a buried concrete vault.

5.2.2 IMPROVING WATER QUALITY

The 2009 and 2016 KCSWDMs place nearly equal emphasis on controlling peak discharge and protecting water quality. The goal in protecting water quality is to prevent TSS, oils, heavy metals, and a host of other pollutants from reaching rivers and streams. This is generally achieved by some form of filtration. Settling, which may be achieved in a traditional pond or vault, is an effective treatment for TSS but does very little to remove fine particles, oils, or dissolved contaminants.

There are already a significant number of facilities within the City that are classified as bioswales or stormfilters, highlighting the higher water quality treatment standards that have been implemented since adoption and enforcement of the 2005 KCSWDM. Filtration has two fundamental approaches: mechanical and biological.



- **Mechanical filtration** includes stormfilters and oil-water separators that use some form of natural or artificial media to strain pollutants from the flow. This media usually needs to be maintained and replaced at some defined interval for the facility to continue the designed function.
- **Natural filtration** includes bioswales, treatment wetlands, and grass filter strips, which use the inherent ability of vegetation to absorb pollutants and trap sediment to achieve water quality improvements. Natural filtration methods take more work to establish and require regular maintenance to prevent sediment accumulation or colonization by invasive weeds.

5.3 STORMWATER RETROFIT PROJECT EVALUATION

5.3.1 RETROFIT RANKING RESULTS

This section presents the results of the City's retrofit ranking results for drainage plats with existing stormwater facilities. Table 5-1 shows the top 25 ranked existing stormwater facilities that were identified as needing retrofit actions. A detailed methodology for facility assessment and ranking can be found in Appendix XX. After these facilities were identified, City staff applied additional feasibility criteria and known system deficiencies to come up with five retrofit projects to be added to the CIP project list. With the update of this Plan, conceptual pre-design reports for these five facilities are provided in Appendix XX.





Table 5-1. Top 25 Retrofit ranking for drainage plats with existing stormwater facilities

Rank	Facility / Drainage Plat Name	Facility Description				
1	Taylors Ridge I (No. 1)	Detention Pipe in ROW (150 th St) (public facility)				
2	Taylors Ridge I (No. 2)	Detention Pipe in ROW (150 th St) (public facility)				
3	Duvall Highlands Mobile Home Park	Pond (privately owned)				
4	Big Rock Ridge Div. 1-3 (South Pond)	Pond (public facility)				
5	Big Rock Ridge Div. 1-3 (North Pond)	Pond (public facility)				
6	Houston Barclay Building	Detention Pipe (privately owned)				
7	US Post Office	Oil/Water Separator (privately owned)				
8	Kasper Heights Div. 1	Pond (public facility)				
9	Cedarcrest High School (1992)	Pond (privately owned)				
10	278 th Street Improvements	Detention Pipe in ROW (278 th St) (public facility)				
11	Chapman Div. 1	Bioswale (public facility)				
12	Bruett Road Phase II (a.k.a. 152 nd St)	Pond (public facility)				
13	Cedar Grove	Pond (public facility)				
14	Cedarbrooke	Pond (public facility)				
15	Duvall Town Center (a.k.a. Chevron)	Detention Pipe (privately owned)				
16	NE 150 th Road Improvements (1996)	Detention Pipe in ROW (150 th St) (public facility)				
17	Taylors Ridge Div. 1 & 2	Bioswales to Vault (public facility)				
18	Legacy Ridge	Pond (public facility)				
19	Braithburn Academy	Infiltration pipe (privately owned)				
20	Big Rock Road	Bioswale (public facility)				
21	Cherry Valley Vista	Detention Pipe (public facility)				
22	Cherrybrooke	Detention Pipe (public facility)				
23	150 th Vault (CHS off-site)	Vault (public facility)				
24	Ritas Homestead	Bioswale (public facility)				
25	The Ridge	Pond (public facility)				

The five highlighted facilities have been identified as the City's top priorities and are included on the CIP project list



5.3.2 Top Five Retrofit Projects

Duvall Highland Mobile Home Park - Pond (Ranked #3)

This is a shallow asphalt lined, privately owned and maintained 'flow-through' pond, Figure 5-2. The City is proposing to either create a partnership with the property owners, or take over ownership and maintenance of the facility. Currently the pond has little to no storage or water quality attributes. Design could include accommodation of stormwater from future ROW improvements along NE 142nd Place and expansion into the ROW.



Figure 5-2. Duvall Highlands Mobile Home Park Pond

Facility Opportunities and Efficiencies

This stormwater facility ranked third in the City's watershed based approach to improve stormwater management. Based on the age of the facility and 2016/2017 stormwater management standards, the opportunity to add water quality and increase detention volumes will protect and improve downstream systems. This project will incorporate a larger, deeper stormwater pond to comply with 2016 KCSWDM flow control and water quality standards as well as incorporating low impact development (LID) techniques. These LID approaches include but are not limited to: increased tree canopy coverage, water



quality components, and right-of-way (NE 142nd Place) bioretention options. This project also provides unique opportunities including:

- Reduced peak flow and improved water quality to the Unnamed South Tributary Lower watersheds and sensitive downstream conditions associated with the NE Big Rock Road drainage.
- A public/private partnership between the City and MHP
- Treatment and detention for offsite properties located north of the MHP that currently drain to the MHP facility.
- Treatment, detention, and possible coordinated construction for the NE 142nd Non-motorized improvement project (TIP# C-1 and C-2)
- Incorporation of BMP T7.30: Bioretention Cells
- Incorporation of BMP T5.16: Tree Retention
- Incorporation of BMP T5.13: Post Construction Soil Quality and Depth
- Incorporation of BMP T10.40: Combined Detention and Wetpool Facilities

The facility is located in the southwest corner of King County parcel: 1926079005 at address: 28000 NE 142nd Place, Duvall, WA 98019.



Big Rock Ridge Div. 1-3 – North Pond (ranked #5)

This is a large pond that discharges south of NE Big Rock Road out of City limits into a sensitive drainage (unnamed stream) area. There is room in the northwest of this facility to incorporate the Laura Vera Estates (#57) detention pipe which is occupying a City owned parcel, and possibly Big Rock Road (#20) bioswale. The intent is to add storage and water quality and possibly eliminate the Laura Vera Estates detention pipe. Monumentation, informational signage (LID), and park equipment could also be incorporated for this project.



Figure 5-3. Big Rock Ridge Pond and Laura Vera Detention Pipe

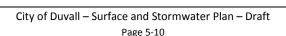
Facility Opportunities and Efficiencies

This stormwater facility ranked third in the City's watershed based approach to improve stormwater management. There is a possibility to regionalize this facility to add water quality and increase detention volumes to protect and improve downstream systems. This project will incorporate a larger, deeper stormwater pond to comply with 2016 KCSWDM flow control and water quality standards as well as incorporating low impact development (LID) techniques. These LID approaches include but are not limited to: increased tree canopy coverage, large bioretention components, and right-of-way (282nd Place NE and NE Big Rock Road) water quality options.



- Reduced peak flow and improved water quality to the Unnamed South Tributary Upper watersheds and sensitive downstream conditions associated with the NE Big Rock Road drainage.
- Possible consolidated drainage with the Laura Vera Facility (located upstream and to the north) and 282nd Ave NE intersection bioswale.
- Incorporation of BMP T7.30: Bioretention Cells
- Incorporation of BMP T5.16: Tree Retention
- Incorporation of BMP T5.13: Post Construction Soil Quality and Depth
- Incorporation of BMP T10.40: Combined Detention and Wetpool Facilities

This facility is located on the King County parcel: 0808300250 in the northeast corner of the intersection at NE Big Rock Road and NE Roney Road. The facility is owned and maintained by the City of Duvall. The Laura Vera Estates detention pipe is located to the northwest on the vacant, City owned King County parcel: 4213500170. The Big Rock Road bioswale is location on City owned, King County parcel: 6672930380 in the NE corner of the intersection at NE Big Rock Road and 282nd Place NE (Error! Reference source not found.).





Kasper Heights Div. 1 (ranked #8)

This is a pond/bioswale/detention pipe facility, Figure 5-4, which discharges within City limits to downstream ditches and ultimately south of NE Big Rock Road out of City limits into a sensitive drainage area with previous drainage complaints. There is opportunity to add storage volume to the facility and possibly reconfigure the water quality portion to reduce burdens on downstream conveyance.



Figure 5-4. Kasper Heights Pond and Bioswale

Facility Opportunities and Efficiencies

This stormwater facility ranked eighth in the City's watershed based approach to improve stormwater management. Based on the age of the facility and 2016/2017 stormwater management standards, the opportunity to add water quality and increase detention volumes will protect and improve downstream systems. This project will incorporate a larger, deeper stormwater pond to comply with 2016 KCSWDM flow control and water quality standards as well as incorporating LID techniques. These LID approaches include but are not limited to: increased tree canopy coverage, and improving water quality components.



- Reduced peak flow and improved water quality to the Unnamed South Tributary Lower watersheds and sensitive downstream conditions associated with the NE Big Rock Road drainage and drainage complaints within unincorporated King County south of City Limits.
- Incorporation of BMP T5.16: Tree Retention
- Incorporation of BMP T5.13: Post Construction Soil Quality and Depth
- Incorporation of BMP T10.40: Combined Detention and Wetpool Facilities

This facility is located on the King County parcel: 3793400420 in the northeast corner of the intersection at 275th Avenue NE and NE 140th Place.





Cedarcrest High School – 1992 Pond (ranked #9)

This facility was designed and built in 1992 during construction of Cedarcrest High School and originally discharged from the east pond, Figure 5-5, through a 200-foot grass-lined swale onto undeveloped property to the north. Since the construction of Cedarcrest High School, athletic field improvements have updated aspects of the stormwater system and incorporated new components. A swale was added to the inlet of the pond in 2002 when the synthetic football field was constructed. In 2013, the bioswale was improved and relocated. The design intent is to increase storage volume of the 1992 pond and possibly relocate the outlet to discharge to the northeast onto School District owned property, minimizing downstream impacts.



Figure 5-5. Cedarcrest High School East Pond

Facility Opportunities and Efficiencies

This stormwater facility ranked ninth in the City's watershed based approach to improve stormwater management. Based on the age of the facility and 2016/2017 stormwater management standards, the opportunity to add water quality and increase detention volumes will protect and improve downstream systems. This project may incorporate a deeper stormwater pond to comply with 2016 KCSWDM flow control and water quality standards as well as incorporating low impact development (LID) techniques. These LID approaches include but are not limited to: water quality and detention components with steep



slopes, and improving existing dispersion/infiltration trench. This project will also include a public/public cooperation between the City and the Riverview School District.

- Reduced peak flow and improved water quality to steep slopes associated with the Cherry Creek
 C watersheds and sensitive downstream conditions associated with the Cherry Creek Tributary
 drainage.
- A partnership between the City and Riverview School District.
- Possible coordinated construction of a new outfall facility to improve dispersion and infiltration.
- Incorporation of BMP T7.20: Infiltration Trenches (depending on soil conditions).
- Incorporation of BMP T5.16: Tree Retention.
- Incorporation of BMP T5.13: Post Construction Soil Quality and Depth.
- Incorporation of BMP T10.40: Combined Detention and Wetpool Facilities

This facility is located in the northeast corner of King County parcel: 1826079013 at address: 29000 NE 150th Street, Duvall, WA 98019.





Cherry Valley Vista (ranked #21)

This facility includes detention pipes, bioswale, and culverts, Figure 5-6. Currently there is a significant impact downstream during the wet season as the bioswale is no longer established or functioning. Water tops the ditch and culvert system and flows over NE Cherry Valley Road. The existing culverts are nearing failure with piping observed along the culverts. There is a large area where a storage or water quality cell could be added, or the bioswale could be re-established. Additional improvements could include mitigation or replacement of the cross-culvert beneath NE Rupard Road.

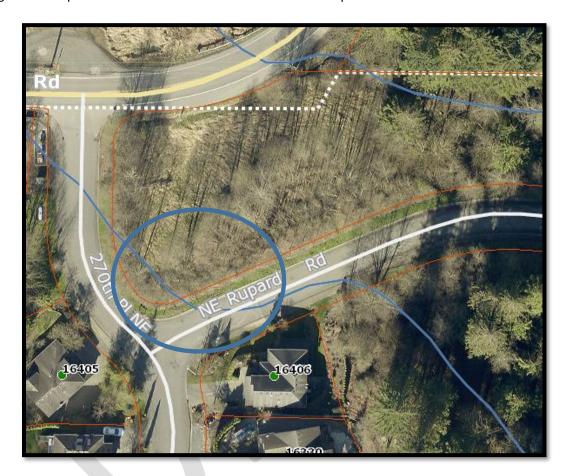


Figure 5-6. Cherry Valley Vista Detention Pipes

Facility Opportunities and Efficiencies

This stormwater facility ranked twenty-one in the City's watershed based approach to improve stormwater management. Based on the age of the facility and 2016/2017 stormwater management standards, the opportunity to add flow control and water quality features will protect and improve downstream systems. This project will incorporate a new stormwater pond to comply with 2016 KCSWDM flow control and water quality standards as well as incorporating low impact development (LID) techniques. These LID approaches include but are not limited to: water quality and detention components, while possibly improving fish passage elements (for the culvert segment).



- Improved water quality to the Cherry Creek A watersheds and sensitive downstream conditions associated with the tributary of the Cherry Valley Creek drainage.
- Possible coordinated construction and mitigation with the Rupert Road culvert fish passage barrier.
- Possibly improve on-site wetlands/re-establish bioswale.
- Incorporation of BMP T7.30: Bioretention Cells
- Incorporation of BMP T5.16: Tree Retention
- Incorporation of BMP T5.13: Post Construction Soil Quality and Depth

The detention pipes are located within the right-of-way, parallel to the curb-line in NE Rupard Road, and culverts cross under NE Rupard Road conveying a tributary creek. The bioswale area is on the King County parcel: 1558500320 at the northeast corner of the intersection of 270th Place and Rupard Road.

5.4 CHAPTER 5 REFERENCES

No references for this Chapter; stormwater systems analysis methodologies detailed in Appendix XX.

Page 5-16



CHAPTER 6. FUNDING AND FINANCING PROGRAM

6.1 FISCAL POLICIES AND FINANCIAL STATUS

Funding and Financing of stormwater infrastructure operations, maintenance, and improvements are a vital component of a successful Stormwater Utility and associated environmental stewardship. Storm Drainage Utility rates and City allotted funds for professional services allow the City to maintain its existing infrastructure and plan for replacement of infrastructure that is nearing the end of its functional lifecycle.

Operations and Maintenance activities are typically funded through rate-payer monthly fees paid into the 404 Storm Drainage Utility Fund. These fees pay for personnel, equipment, and other resources required for regular operations. Storm Drainage Utility rates and annual budget are determined through processes separate from adoption of this Plan and documented by Duvall Municipal Code Chapter 9.06 (Storm Drainage Utility) and associated Fee Ordinances. Storm Drainage Utility revenue in the 404 Storm Drainage Utility Fund was approximately \$724,939 in 2017, and has seen an average 4% annual growth from 2014 to 2017, largely due to annual inflation adjustments and increases in the number of dwelling units across the City.

Capital system improvements, such as retrofits and conveyance improvements, are typically funded through development-related fees paid into the City's 409 Storm Drainage Capital Improvement Fund, supplemented by grants and other resources. Development-related stormwater acreage revenues have varied based on the amount of development occurring each year. The development-related stormwater revenue for 2017 was approximately \$83,937.

In addition to these revenue sources, the City's budget for stormwater operations, maintenance, and capital improvements has been supplemented by one-time, variable funding sources. From 2012-2017, these sources have included:

- King Conservation District grants
- King County Flood Control District Sub-Regional Opportunity Fund grants
- Washington State Department of Ecology NPDES Municipal Capacity Grants: for NPDES Permit implementation and water quality retrofit planning (future allocations are likely)
- One-time grants for both capital construction and studies. To provide just a few examples, the
 City was awarded \$155,020 for the Carrie-Rae Pond Retrofit Project in 2013, \$203,468 for the
 Parkwood Pond retrofit project in 2017, and was awarded approximately \$200,000 for this
 Surface and Stormwater Planning and Retrofit Pre-Design project in 2015/2016. A full list of recent
 grants is shown in Table 7-2. Grant funding received between 2008-2016

Error! Reference source not found. lists recent revenues for stormwater improvements.



Table 6-1. Summary of Existing Revenue for Operations, Maintenance and Capital Improvements of the City's Storm Drainage Utility.

	404 Storm Drainage Utility revenue	409 Storm Drainage Capital Improvement Fund	One-Time Grants
2014	\$656,580	\$7,684	\$41,820
2015	\$679,063	\$1,890	\$80,018
2016	\$701,536	\$2,286	\$11,213
2017 (Year End Estimate)	\$724,939	\$83,937	\$440,816
Annual Average	\$690,529	\$23,949	\$143,466

6.1.1 FUTURE REVENUE

Potential rate and fee impacts associated with this Plan's recommendations were a primary consideration in identifying required surface and stormwater services, with the goal of minimizing the need for additional revenue over the life of the Plan. The City recognizes that the Storm Drainage Utility rates and development impact fees collected over the last twenty years have been less than the annual costs of appropriate operations and maintenance of existing publicly owned facilities and capital improvements. Completion of these activities and associated system capital improvements have been heavily dependent on grant revenues, which have accounted for approximately 20% of all available stormwater funding in the 2012-2017 timeframe.

The City owned and operated Storm Drainage Utility served approximately 2,548 accounts in 2017. Commercial, multi-family, and other non-residential Storm Drainage Utility customers within the City pay a monthly storm drainage utility fee that is directed to the City's 404 Storm Drainage Utility Fund. These charges are based on the number of "equivalent residential units" (ERUs) of impervious surface on the property, where one ERU equals 3,000 square feet of impervious surface. Single-family residences pay a flat fee of 1 ERU and commercial properties pay a fee based on impervious area measurements completed by the City from recent air-photos. The monthly rate for each ERU is adjusted annually every January based on the 12-month average (July—June) percent change in Consumer Price Index for All Urban Consumers (CPI-U) for the preceding two years within the Seattle-Tacoma-Bremerton area. The 2017 Storm Drainage Utility rate for a single-family residence was \$19.56 per month (\$234.72 annually).

Developers pay a one-time Storm Drainage Acreage Charge which accounts for the developer portion of cost associated with the CIP. The Storm Drainage Acreage Charge is collected at Final Plat or Commercial Building Permit Approval and is used to help fund system improvements that are needed to serve, or mitigate impacts from future growth. All revenue collected from these fees are directed to the City's 409 Storm Drainage Capital Improvement Fund. According to DMC 9.06.120, the fund is to be "used to pay the



cost and expense of constructing and installing general facilities for storm drainage and flood control". Monies within this fund can be supplemented by contributions from other sources such as grants. This fund has been the primary source for implementing facility retrofits. The 2017 acreage charge was \$1,972 per acre or fraction thereof; the acreage charge had not been increased or otherwise adjusted since 2001 except for annual inflationary increases. Funds collected between 2001-2017 were insufficient for completion of capital projects. A new Stormwater General Facility Charge (GFC) at Residential and Commercial Building permit issuance is proposed as part of this Plan to further mitigate impacts from new development and provide funding for capital projects.

6.2 DEVELOPER IMPROVEMENTS

The City has adopted specific requirements for new development and redevelopment which include installation of on-site stormwater facilities along with roadway frontage stormwater improvements. Mitigation of identified downstream drainage deficiencies is also required in accordance with King County Surface Water Design Core Requirement 2 (Section 1.2.2.2) and other City requirements. LID techniques, retrofit of existing facilities, and other measures to reduce the burden on stormwater infrastructure, is promoted by the City at all project stages from preliminary design to construction.

The City also evaluates development impacts under the State Environmental Policy Act (SEPA) guidelines. A SEPA review process may identify adverse stormwater impacts that require additional mitigation beyond installation of improvements to manage water quality and quantity. These impacts and mitigation measures could be related to downstream private water supplies, sensitive areas, erosion hazards, habitat and endangered species, or other stormwater issues. The needed improvements may or may not be identified as specific projects in this Plan.

6.3 COST SUMMARY

The City has prepared an updated Capital Improvements Plan (CIP) which details the anticipated project costs, including total Capital Improvements and on-going Citywide Programs, from 2018 to the 2035 horizon year. These costs are summarized in Table 6-2. The improvement projects and programs are estimated to cost approximately \$8.87 million in 2017 dollars as summarized on **Error! Reference source not found.**, project list in Chapter 6. Approximately \$3.33 million of the total project costs are associated with future development and are considered as the basis for calculation of the Storm Drainage Acreage Charge and proposed Stormwater General Facility Charge. The remaining \$5.54 million of total project costs represents the City's portion of these costs. This requires approximately \$326,000 per year of City and/or grant funds over the life of this Plan. The CIP is discussed in more detail in CHAPTER 7.



Table 6-2. 2018 to 2035 Project Cost Summary

Capital Improvements	3	Citywide Programs		
Description	Costs (\$1,000's)	Description	Costs (\$1,000's)	Total Costs (\$1,000's)
Retrofit Projects (Projects R1-R12)	\$3,853	Conveyance and other facility or Citywide improvements (Projects O-1 to O-9)	\$1,147	
Culvert/Outfall Repair or Replacement (C-1 to C-6)	\$1,852	Education and Outreach (Project O- 10)	\$ 85	
Minor Conveyance and/or Water Quality Improvements (I-1 to I-8)	\$1,833	Stormwater Plan, Standards, and Code Updates (Project O-11)	\$100	
Subtotal	\$7,539		\$1,332	\$8,871

6.4 DEVELOPMENT FORECAST (2018 TO 2035)

The City of Duvall Public Works and Planning Departments completed a buildable lands study to support development of the 2015 Comprehensive Plan amendment. The study includes baseline measurements for residential and commercial uses within the City as of January 1, 2015 and forecasts future growth for a period of 20 years, to the horizon year of 2035. This is summarized in the memorandum titled *City of Duvall 2015 Capacity and Transportation Analysis Study/EIS Alternatives* (Duvall, 2017) and shown in Table 6-3.

Table 6-3. 2018 to 2035 Development Forecast

	Parcel Area (Acres)	Dwelling Units (Units)	Commercial Floor Area (SF)	Light Industrial Floor Area (SF)	Commercial Impervious Area (SF)	Light Industrial Impervious Area (SF)
2015 Existing Total Development	963	2,657²	370,0212	56,200²	2,602,330	233,988
2035 Anticipated Total Development	1412 ³	3,884²	789,767²	89,685 ²	5,554,372	373,402
2015-2035 Anticipated Change in Development	449 ¹	1,227³	419,746³	33,485 ³	2,952,042	139,414
2015 – 2017 Actual Development	204	145 ⁴	04	04	0	0
2018 - 2035 Anticipated Change in Development	429 ⁵	1,0825	419,746 ⁵	33,485 ⁵	2,952,042	139,414

 $^{{\}it ^3} Table~5b, City~of~Duvall~2015~Capacity~and~Transportation~Analysis~Study/EIS~Alternatives~(Duvall,~2017).$

²Table 7, City of Duvall 2015 Capacity and Transportation Analysis Study/EIS Alternatives (Duvall, 2017).

³Difference between 2035 Anticipated Development and 2015 Existing Development.

Based on City of Duvall Building Department Data for new homes in 2015-2017 (Year End Estimate), Parcel Area estimated at an average 6,000 SF.

 $^{^5\}mbox{Difference}$ between 2015-2035 Anticipated Development and 2015-2017 Actual Development.



6.5 REVENUE REQUIREMENTS

The financial analysis of the Surface Water Utility is intended to provide a focused review of the overall financial health of the utility and the revenue needed to implement the recommendations of this Surface and Stormwater Plan. The following sections summarize recommended revenue approaches to fund the proposed Plan.

6.5.1 404 STORM DRAINAGE OPERATIONS UTILITY EUND

404 Storm Drainage Operations Utility Fund charges are billed as monthly rates to customers and contribute to operations and maintenance activities along with minor system improvements. These funds pay for staff, equipment, services, and other resources required for day-to-day operation of the Storm Drainage Utility.

A City of Snoqualmie report documented that the Storm Utility rate at seven eastern Puget Sound Cities ranged from \$11.36 (Monroe) to \$28.36 (Bellevue) in 2017 (Snoqualmie, 2017). The City of Duvall 2017 rate was the third highest of the nine cities at \$19.56 per month (\$234.72 annually) in 2017 as summarized in Figure 6-1.

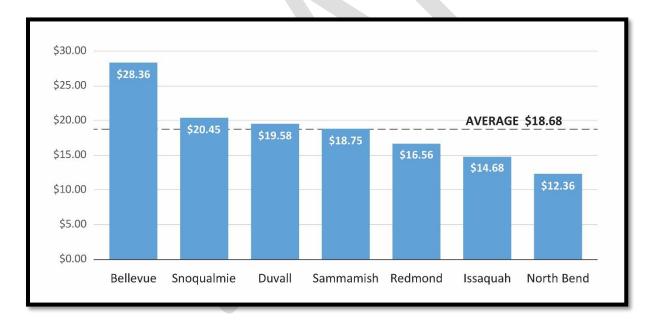


Figure 6-1. Summary of 2017 Monthly Storm Utility Rates at Seven Cities

Annual 404 Storm Drainage Operations Utility Fund rate revenue and expenses associated with operations and maintenance were relatively balanced from 2014 to 2017 suggesting appropriate rate amounts during that timeframe. However, approximately \$146,000 in Department of Ecology NPDES Municipal Capacity Grant revenue directly offset operation and maintenance costs during this time as well. Therefore, lack of future grant revenue could result in a revenue shortfall for the 404 Storm Drainage Operations Utility



Fund. However, changes to the 2017 Storm Drainage Utility rate and structure are not recommended as part of this plan based on rate comparison with nearby cities.

6.5.2 409 CAPITAL IMPROVEMENT FUND

409 Storm Drainage Capital Improvement Utility Fund revenues are reserved for completion of retrofits, conveyance capacity improvements, and other general system improvements. Prior to 2018, revenue to the 409 Storm Drainage Capital Improvement Utility Fund was limited to one-time Storm Drainage Acreage Charge charged at final plat or Commercial Building Permit Approval at the 2017 rate of \$1,972 per acre or fraction thereof. Revenue in the 2014 to 2017 timeframe totaled \$95,797 which did not provide sufficient funds for Capital Project completion.

The City's Storm Drainage Acreage Charge is a bulk acreage charge independent of actual use, development density, or burden on the stormwater system and environment. Stormwater capital improvement charges vary among neighboring cities in eastern Puget Sound. However, most cities (except Duvall) charge GFCs as opposed to an acreage charge. These GFCs are generally based on square feet (SF) of impervious surface coverage or an ERU for each single-family residence (SFR). Conversion of the City's 2017 Storm Drainage Acreage Charge to an equivalent GFC ERU would vary from \$99/ERU for R-20 (20 units per acre) to \$493/ERU for R4 (four residential units per acre) with an ERU equal to a Single Family Residential (SFR) lot or 3,000 SF of impervious (DMC 9.06.125.C). Table 6-4 summarizes 2017 Stormwater Capital Improvement charges from nearby cities.

Table 6-4. Summary of 2017 One-Time Storm Capital Charges at Seven Cities.

City	General Facility Charge (SFR)	Notes
Bellevue	\$999	Capital Recovery Charge for each SFR (based on \$5.55/2,000 SF per month for 10 years, normalized to 3,000 SF for consistency with Duvall rate structure).
Snoqualmie	\$328	General Facility Charge for each SFR
Duvall*	\$99 to \$493	Conversion from Storm Drainage Acreage Charge to ERU basis for each SFR (R-20 to R4)
Sammamish	\$1,491	System Development Charge (\$1,491 for \$2,500 SF, an additional \$298 for 500 SF to normalize to 3,000 SF for comparison)
Redmond	\$1,437	Stormwater Capital Facility Charge (based on \$958/2,000 SF, normalized to 3,000 SF for comparison)
Issaquah	\$1,256	General Facility Charge per SFR
North Bend	\$800	Per SFR (based on \$800/2,920 SF)
Average	\$916 to \$972	

^{*}The City of Duvall is proposing a *new* General Facility Charge based on SFR



The 2017 Storm Drainage Acreage Charge was found to be less than capital charges for nearby cities. This charge did not provide sufficient funds for Capital Project completion prior to 2017, and was found to provide insufficient funds for the 2018-2035 CIP within this plan. As proposed, revenue from the Storm Drainage Acreage Charge would pay half of the Development-related Capital Improvements summarized in Error! Reference source not found. and revenue from a new GFC would pay for the remaining half of **Development-related Capital Charges**

To increase revenue into the City's 409 Storm Drainage Capital Improvement Utility Fund and encourage additional use of LID BMPs as new development occurs, the following is recommended as part of this plan:

 The Storm Drainage Acreage Charge, paid based on site acreage at the time of final plat, standalone new residential, or commercial building permit, should be adjusted upward from \$1,972 per acre or fraction thereof, to \$3,878 per acre outline in Table 6-5:

Table 6-5. Storm Drainage Acreage Charge for 2018-2035 Anticipated Change in Development.

Total Development- Related Costs	•		Acreage Cost (2017 Dollars) ¹
\$3,327,042	\$1,663,521	429	\$3,878

¹Half of Development-Related Costs/Parcel Area (Acres)

 A new General Facility Charge, with allowed reductions where applicants agree to implement additional LID BMPs beyond minimum requirements, is outlined in Table 6-6.

Table 6-6. General Facility Charge for 2018-2035 Anticipated Change in Development.

Total Development- Related Costs	Half of Development- Related Costs	Dwelling Units ERUs	Total Commercial & Light Industrial Area ERUs ¹	Total ERUs	ERU Cost (2017 Dollars)
\$3,327,042	\$1,663,521	1,082	302	1,384	\$1,202

¹Total Commercial and Industrial SF/3000 SF per ERU

6.5.3 409 CAPITAL IMPROVEMENT FUND GFC INCENTIVES

This plan includes proposed GFC reductions where applicants agree to implement additional LID BMPs beyond minimum requirements:

- 100% GFC with standard infrastructure and minimal LID BMP implementation because of site limitations.
- Reduction of the GFC to 75% where LID BMPs are used as part of residential development to eliminate the need for traditional detention facilities (vaults, ponds, and detention pipes) and other gray infrastructure approaches.
- Reduction of the GFC by a maximum of 50% as part of residential development if storm runoff is kept on-site through use of LID BMPs and traditional facilities are significantly reduced.



 Reduction of the GFC to 75% where LID BMPs are used as part of commercial development to eliminate the need for traditional detention facilities (vaults, ponds, and detention pipes) and other gray infrastructure approaches.

The intent of the proposed residential GFC reduction is to encourage installation of new and emerging technologies focused around LID and preservation of natural systems to manage surface and stormwater. Reduced capital fee revenues will be offset by the long-term system-wide savings for reduced LID repair/replacement costs, as well as reducing required operations and maintenance activities. Proposed commercial GFC reduction intent is similar. Additional Commercial Rate reductions to further encourage management of all privately owned and maintained commercial facilities are allowed in accordance with DMC 9.06.125.E.4.

6.6 Chapter 6 References

- City of Duvall. 2010 (and as amended) Transportation Plan. City of Duvall 2009 Comprehensive Plan Transportation Element. December. Duvall, WA. Available: http://www.duvallwa.gov/DocumentCenter/Home/View/2484
- City of Duvall. 2015. Resolution 15-13, A Resolution of the City Council of the City of Duvall, Washington, Approving the 2016-2021 Six-year Transportation Improvement Plan. Available: http://www.duvallwa.gov/DocumentCenter/Home/View/2474.
- City of Duvall, 2016 (and as amended) City of Duvall 2015 Comprehensive Plan (Resolution No. 16-09). Available: http://www.duvallwa.gov/DocumentCenter/Home/View/2974
- City of Duvall, 2017. Memorandum titled City of Duvall 2015 Capacity and Transportation Analysis Study/EIS Alternatives. Updated June 14, 2017. Available: http://www.duvallwa.gov/documentcenter/view/2048
- City of Snoqualmie, February 2, 2017. Water, Sewer and Storm Utilities Rate Study, Available: http://www.ci.snoqualmie.wa.us/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=25286&PortalId=0&TabId=273



CHAPTER 7. SYSTEM IMPROVEMENTS

7.1 STORMWATER SYSTEM IMPROVEMENTS

7.1.1 CAPITAL IMPROVEMENT PLAN (CIP) DEVELOPMENT

The Capital Improvement Plan (CIP) is a priority list of stormwater system improvement projects and programs that the City hopes to undertake by 2035. Each project in the CIP includes a project description, an estimate of total project cost, the funding approach (proportions of City Storm Fund allocations), and an identified timeframe for implementation. This list developed by Public Works staff based on the systemwide evaluation and analysis summarized in Chapter 5, System Analysis and additional consideration of Public Works current maintenance practices and anticipated maintenance and system improvement needs. The identified improvement projects and programs will help the City to implement the overall Comprehensive Plan goals and policies.

The CIP includes the following categories of water quality, detention, and conveyance improvements and strategies:

- 1. Retrofit Projects
- 2. Culvert / Outfall Repair or Replacement Projects
- 3. Minor Conveyance and/or Water Quality Improvement Projects
- 4. Other Citywide stormwater programs.

Error! Reference source not found. summarize the Stormwater System CIP and specific project locations are depicted in Figure 7-1.

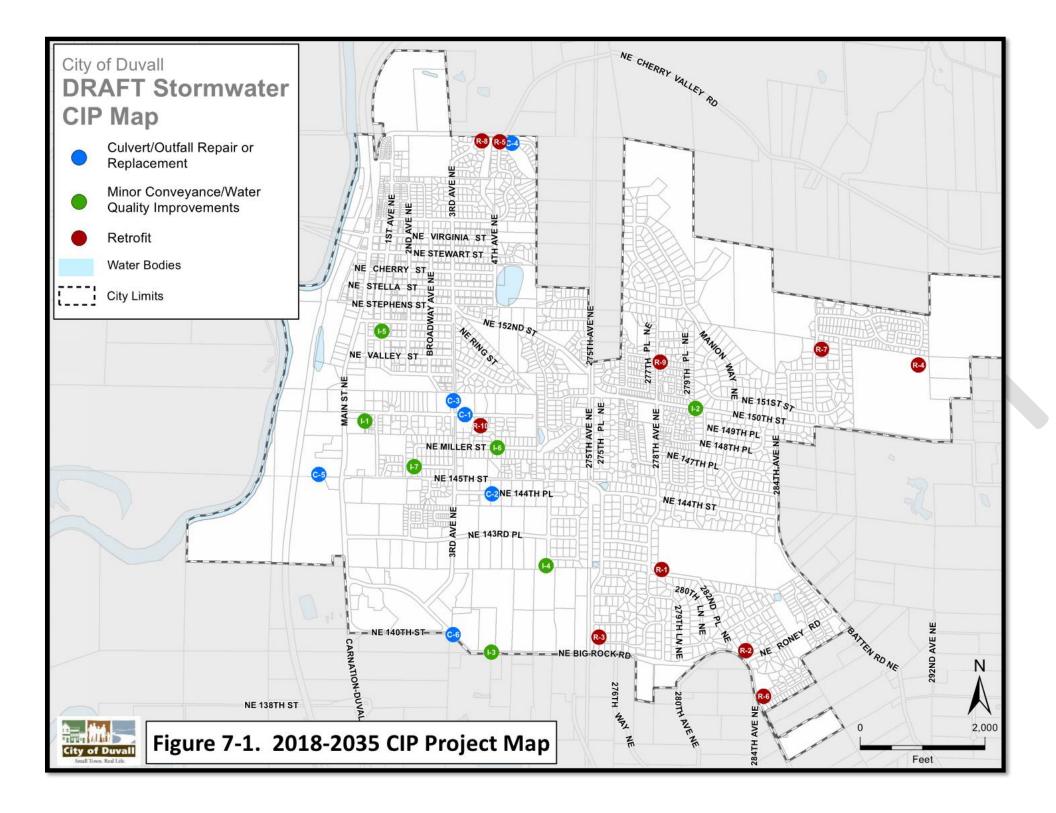


Table 7-1. Stormwater System Capital Improvement Program Project List (2018-2035).

Project	Мар	Procise to Name	Duning at Limite	Dunie at Decembris	Total Project	City F	unds	Developme	ent Charges	Gra	nts	Time
Group	ID	Project Name	Project Limits	Project Description	Cost Estimated	Share (%)	Cost (\$)	Share (%)	Cost (\$)	Share (%)	Costs (\$)	Frame
	R-1	Duvall Highland Mobile Park Homes Pond Retrofit - Public/Private Partnership	Duvall Highlands MHP Stormwater Pond	Expand stormwater pond and increase detention volume to mitigate downstream issues, possibly expanding the facility into existing ROW to accommodate frontage improvement stormwater (requires dedication or easement)	\$267,084	0%	\$0	40%	\$106,834	60%	\$160,250	Short
	R-2	Big Rock Ridge Div. 1-3 (North Pond) Retrofit	NE Big Rock Road and NE Roney Road	Retrofit pond and bioswale to increase detention and water quality while possibly incorporating an older detention pipe to the north (Laura Vera Estates), which could regionalize the facility.	\$536,169	0%	\$0	40%	\$214,468	60%	\$321,701	Short
	R-3	Kasper Heights Div. 1 Retrofit	275th Avenue NE and NE 140th Place	Retrofit stormwater facility to increase storage volumes and mitigate downstream flooding issues	\$454,011	0%	\$0	40%	\$181,604	60%	\$272,407	Short
	R-4	Cedarcrest High School East Pond Retrofit - Public/Public Coop	Cedarcrest High School	Retrofit stormwater facility to increase storage volumes and improve pond outfall.	\$281,757	0%	\$0	40%	\$112,703	60%	\$169,054	Short
CTS	R-5	Cherry Valley Vista Retrofit	270th Place NE and NE Rupard Road	Retrofit stormwater facility to accommodate higher flows while incorporating water quality. May include repair or replace existing hanging/undersized culverts to the east.	\$235,537	0%	\$0	40%	\$94,215	60%	\$141,322	Short
PROJE	R-6	Big Rock Ridge Div. 1-3 (South Pond) Retrofit	NE Big Rock Road and NE 138th Place	Retrofit stromwater pond to increase storage volumes to protect sensitive outfall area south of Big Rock Road (Possibly incorporate PGIS from NE Big Rock Road for additional water quality).	\$460,152	0%	\$0	40%	\$184,061	60%	\$276,091	Mid - Long
RETROFIT	R-7	Legacy Ridge Pond & Bioswale Retrofit	near 15413 286th Avenue NE	Reestablish bioswale and increase storage volume in existing stormwater pond to protect Cherry Creek tributary outfall. Possibly look at bypassing or incorporating high flows from adjacent natural flow path to the west to protect from downstream erosion and sediment transport.	\$849,560	0%	\$0	40%	\$339,824	60%	\$509,736	Mid - Long
32	R-8	Cherrybrooke Bioswale Retrofit	3rd Avenue NE and NE Cherry Valley Road	Retrofit bioswale and incorporate additional water quality features.	\$44,066	0%	\$0	40%	\$17,626	60%	\$26,440	Mid - Long
	R-9	Rita's Homestead Bioswale Retrofit	278th Avenue NE and NE 152nd Street	Retrofit stormwater facility to accommodate higher flows while incorporating water quality. Increase volume/storage of bioswale.	\$115,983	0%	\$0	40%	\$46,393	60%	\$69,590	Mid - Long
	R-10	Cedarbrooke Pond and Bioswale Retrofit	near 26923 NE Kennedy Drive	Retrofit Pond for additional volume/water quality to incorporate neighborhood to the east (PGIS and nine existing homes) and add outfall energy dissipater.	\$179,340	0%	\$0	40%	\$71,736	60%	\$107,604	Mid - Long
	R-V1	Pond Retrofit (various)	Various	Pond Retrofit from included within Table 5-1 of 2018 Surface and Stormwater Plan	\$350,000	0%	\$0	50%	\$175,000	50%	\$175,000	Mid – Long
	R-V2	Bioswale Retrofit (various)	Various	Bioswale Retrofit from included within Table 5-1 of 2018 Surface and Stormwater Plan	\$80,000	0%	\$0	50%	\$40,000	50%	\$40,000	Mid - Long
OR	C-1	Coe Clemons Creek Culvert 1	NE Kennedy Drive	Repair/Replace hanging NE Kennedy Drive Culvert immediately east of 3rd Avenue NE	\$367,217	25%	\$91,804	40%	\$146,887	35%	\$128,526	Mid - Long
EPAIR T	C-2	Coe Clemons Creek Culvert 2	NE 144th Place	Repair/Replace undersized roadway culvert, near 26932 NE 144th Place	\$363,578	25%	\$90,895	40%	\$145,431	35%	\$127,252	Mid - Long
ALL R EMEN	C-3	Coe Clemons Creek Culvert 3	3rd Avenue NE	Repair/Replace hanging 3rd Avenue NE Culvert immediately east of 3rd Avenue NE and north of NE Kennedy Drive	\$366,307	25%	\$91,577	40%	\$146,523	35%	\$128,208	Mid
T/OUTFALL REI REPLACEMENT	C-4	Cherry Creek Tributary Culvert	NE Rupard Road	Repair/Replace culvert beneath NE Rupard Road and associated downstream ditch/swale conveyance (Possible Coordination with Project R-2).	\$368,127	25%	\$92,032	40%	\$147,251	35%	\$128,844	Short
CULVERT/OUTFALL REF REPLACEMENT	C-5	Thayer Creek Outfall	NE 145th Street	Repair/Replace hanging culverts in the southwest corner of Duvall's Wastewater Treatment Plant property.	\$23,851	10%	\$2,385	90%	\$21,466	0%	\$0	Short
CUL	C-6	Unnamed Tributary Culvert	NE Big Rock Road	Repair/replace culvert to address associated flooding issues near 26801 NE Big Rock Road. Add catch basin and piped conveyance upstream if necessary.	\$363,578	25%	\$90,895	40%	\$145,431	35%	\$127,252	Mid



Project	Мар	Droiget Nama	Duois at Limita		Total Project	0103 1 411415		ds Development Charges		Grants		Time
Group	ID	Project Name	Project Limits	Project Description	Cost Estimated	Share (%)	Cost (\$)	Share (%)	Cost (\$)	Share (%)	Costs (\$)	Frame
R	l-1	Kennedy 1 Development outfall swale revision	NE Kennedy Place and 1st Ave NE	Re-establish bioswale to accommodate increased flows and improve bioswale outfall system to reduce bypass flow to the west.	\$55,993	25%	\$13,998	40%	\$22,397	35%	\$19,598	Short
t WATI TS	I-2	NE 150th Street Pavement Removal/LID Improvements	275th Avenue NE to 286th Avenue NE	Remove pollution generating impervious surface (pavement) width and incorporate bioretention/other LID to improve water quality.	\$755,002	25%	\$188,751	40%	\$302,001	35%	\$264,251	Short
MINOR CONVEYANCE AND/OR WATER QUALITY IMPROVEMENTS	I-3	Improve conveyance along Big Rock Road (ditch, catch basins, pipe)	275th Avenue NE to 3rd Avenue NE Extension	Improve conveyance system along the north side of NE Big Rock Road to accommodate increased volumes (tighline or improved ditch section).	\$419,321	10%	\$41,932	90%	\$377,389	0%	\$0	Developer- Driven
ANCE /	I-4	Improve conveyance/outfall from Glen Cairn	272nd Place NE	Improve outfall in the SW corner of Glencairn development by incorporating level spreader or dispersion trench.	\$13,440	10%	\$1,344	90%	\$12,096	0%	\$0	Developer- Driven
ONVEY.	I-5	Improve catch basin/conveyance - 1st Avenue NE	NE Valley Street to NE Stephens Street	Improve stormwater conveyance along 1st Avenue NE to accommodate increased volumes. Includes new pipe and structures along with water quality measures.	\$161,028	25%	\$40,257	40%	\$64,411	35%	\$56,360	Mid
NOR CC	I-6	NE Miller Street Conveyance Improvements (ditch, culverts, catch basins)	NE 3rd Place to Miller Homestead	Improve conveyance system for Coe Clemons Creek tributary along NE Miller Street. Includes realignment of conveyance pipe along the north side of the road and new catch basins.	\$116,480	25%	\$29,120	40%	\$46,592	35%	\$40,768	Mid - Long
Σ	I-7	Improve conveyance (ditch and pipe) in Juniper Glen Plat	2nd Place NE and NE Comegys Street	Improve conveyance with in Juniper Glen subdivision to minimize downstream impacts and improve flooding issues.	\$311,760	25%	\$77,940	40%	\$124,704	35%	\$109,116	Mid
	0-1	Annual Pipe Replacement/CIPP Program/Root Removal Program	Citywide	Citywide program to replace broken/deteriorated/missing storm conveyance pipe or utilize Cured-In-Place-Pipe (CIPP) alternatives as well as addressing root intrusion issues that create flooding problems annually or as necessary.	\$85,000	95%	\$80,750	0%	\$0	5%	\$4,250	On-going
	0-2	Facility Tree Planting Program	Citywide	Citywide program to plant new trees or shrubs for facility screening, shading, and maintenance.	\$17,000	25%	\$4,250	0%	\$0	75%	\$12,750	On-going
	0-3	Disconnect Downspout	Citywide	Public education and outreach program to highlight the importance of finding ways to manage stormwater from your home on site and reduce the burden on existing infrastructure.	\$85,000	25%	\$21,250	0%	\$0	75%	\$63,750	On-going
NS	0-4	Rain Garden Program	Citywide	Public education and outreach program to highlight the importance of incorporating rain gardens to manage stormwater from individual lots and reduce the burden on existing infrastructure.	\$25,500	25%	\$6,375	0%	\$0	75%	\$19,125	On-going
OGRAMS	O-5	Chain Link Fence Upgrades	Citywide	This is an on-going, Citywide effort to remove and replace failing perimeter fencing around City owned and maintained stormwater facilities.	\$340,000	95%	\$323,000	0%	\$0	5%	\$17,000	On-going
CITYWIDE PRO	0-6	Stormwater Facility Baseline Mapping and Asset Management	Citywide	Implementation of an asset management system to compliment and improve operations and maintenance of City owned infrastructure.	\$85,000	95%	\$80,750	0%	\$0	5%	\$4,250	On-going
IWYTI	0-7	Catch Basin Cleaning	Citywide	On-going Citywide program (NPDES requirement)	\$170,000	25%	\$42,500	0%	\$0	75%	\$127,500	On-going
	0-8	Maintenance and Operations	Citywide	On-going Citywide program to maintain vegetation and infrastructure.	\$255,000	25%	\$63,750	0%	\$0	75%	\$191,250	On-going
	O-9	General Old Town Water Quality Improvements Program	Old Town	Incorporate low impact development (LID) techniques into Old Town to maximize basic treatment of pollution generating impervious surfaces (PGIS).	\$85,000	25%	\$21,250	0%	\$0	75%	\$63,750	On-going
	0-10	Education and Outreach Program	Citywide	On-going Citywide program (NPDES requirement)	\$85,000	25%	\$21,250	0%	\$0	75%	\$63,750	On-going
	0-11	Stormwater Comprehensive Plan Update	Citywide	On-going effort to keep goals, policies, and design standards current with Federal regulations.	\$100,000	25%	\$25,000	40%	\$40,000	35%	\$35,000	On-going





7.2 IMPROVEMENT PROJECTS AND PROGRAMS

7.2.1 RETROFIT PROJECTS

The CIP incorporates ten of the highest-ranking stormwater retrofit projects identified in Chapter 5, System Analysis, as well as two general "various" retrofits (pond and bioswale) whose locations may be selected at a future date based on opportunities such as nearby construction projects or available grants. These projects will improve water quality and detention and benefit downstream receiving water bodies. Facility retrofits will also incorporate LID BMPs such as bioretention, increased canopy cover, and other approaches, as possible.

7.2.2 CULVERT / OUTFALL REPAIR OR REPLACEMENT PROJECTS

Repair and or replacement of undersized or non-functioning culverts along creek reaches within City limits will reduce potential flooding issues, eliminate fish barriers, and provide improved access to upstream habitat. The creeks identified for culvert replacement in the CIP list include: Coe Clemons Creek, Thayer Creek, Cherry Creek Tributary, and an Unnamed tributary of the Snoqualmie River that crosses beneath NE Big Rock Road.

7.2.3 MINOR CONVEYANCE AND/OR WATER QUALITY IMPROVEMENT PROJECTS

Improvements to conveyance include removal of pollution generating impervious surfaces (PGIS), ditch maintenance, improving existing conveyance pipe, and adding structures when necessary. The approach to these projects are similar to the *Retrofit Projects*, but on a smaller scale. The purpose of minor conveyance and or water quality improvements are to minimize flooding and mitigate impacts as shown in Table 7-1.

7.2.4 CITYWIDE IMPROVEMENT PROGRAMS

The Surface and Stormwater Plan includes eleven Citywide improvement programs:

- Annual Pipe Replacement/Cured-In-Place Pipe (CIPP) Program/Root Removal Program;
- Facility Tree Planting Program;
- Disconnect Downspouts;
- Rain Garden Program;
- Education and Outreach Program;
- General Old Town Water Quality Improvement Program;
- Chain Link Fence Upgrades;



- Catch Basin Cleaning;
- Maintenance and Operations;
- Stormwater Facility Baseline Mapping and Asset Management; and
- Surface and Stormwater Plan Update.

The Annual Pipe Replacement/Cured-In-Place Pipe (CIPP) Program/Root Removal Program will be used to preserve and enhance the City's existing and planned stormwater system. The program provides the City with a systematic approach for evaluating piped conveyance networks for pipe/structure condition, root intrusion, blockages, sediment accumulation, and other similar conveyance issues. The City will need to consider allocating a significant annual budget including funding for staff resources to administer the maintenance, operations, and capital programs to ensure that the stormwater infrastructure is preserved in a cost-effective manner. For regional improvements, staff resources will be used to prepare grants and coordinate with local and federal governing entities.

The Facility Tree Planting Program will be used by the City to improve tree canopy area to enhance water quality, shading, and facility screening. The program will focus on locations not covered by a specific capital project shown in Table 7-1, and will allow the City to fill gaps in canopy coverage that are needed to provide habitat, improved interception and evapotranspiration, and other associated benefits.

The *Disconnect Downspouts,* the *Rain Garden Program* and the *Education and Outreach Program* will be used in conjunction with the NPDES Permit requirements to promote LID techniques and BMPs for stormwater management.

The *General Old Town Water Quality Improvement Program* includes incorporating LID techniques and water quality features where no stormwater management facilities exist. This program will work with other City capital projects and programs to integrate LID BMPs into project design. Staff resources will be used to prepare grants and coordinate with local and federal governing entities.

The Chain Link Fence Upgrades, Catch Basin Cleaning, and Maintenance and Operations programs are key to maintaining proper function of stormwater infrastructure. These programs address public facilities including but not limited to; ponds, pipes, structures, vaults, catch basins, bioswales, infiltration trenches, and ditches.

The Stormwater Facility Baseline Mapping and Asset Management, and Surface and Stormwater Plan Update programs include updating and maintaining records for asset management and complying with local and federal regulations and requirements.

7.3 PROJECT COST ESTIMATES

Cost estimates for Retrofit Projects R-1 through R-5 were based on specific engineering estimates for those projects. Cost estimates for the remaining Retrofit projects (R-6 through R-V2) were develop based



on the cost estimates developed for projects R-1 through R-5 and historical costs from the 2017 Parkwood Estates Retrofit project, and other recent project work.

Cost estimates for Culvert/Outfall repair and replacement projects C-1 to C-6 and Minor Conveyance and/or Water Quality Improvements projects I-1 to I-7 were developed based on historical costs from the 2017 Parkwood Estates Retrofit project, the 2016-2017 Main Street Project, and other recent project work. Citywide program costs were developed based on historical costs associated with existing programs along with estimates for new programs based on project level of effort.

The proportion of City Funds, Developer Capital Charges, and possible grant funds were developed based on review of past project funding, available grant funding, and an evaluation of developer-related burden. These funding sources are discussed below, and additional information concerning funding and economic analysis is presented in Chapter 7, Funding and Financing Program.

Grants:

Over the past several years the City has secured grants for several Citywide improvement projects. Based on the recent past grant revenues, this source could provide up to \$1.5 million in revenues to fund the Plan. Grant funding is typically tied to specific improvement projects and is distributed on a competitive basis. However, the City has also received a "Capacity Grants" from Ecology for general stormwater improvements. Recent grant funding is shown below in Table 7-2.

Table 7-2. Grant funding received between 2008-2016

Fiscal Year (FY)	Project Name	Amount Received
FY 08-10	NE 145 th Street / 275 th Avenue NE	\$90,000
FY 10-11	Ecology Pass-Through Grant	\$50,000
FY 11	Ecology Capacity Grant	\$85,834
FY 11	Pond Retrofit (Carrie Rae)	\$140,400
FY 11	Sub-Regional Opportunity Fund	~\$30,000
FY 13	Ecology Capacity Grant	\$30,000
FY 14	Ecology Capacity Grant	\$50,000
FY 14	Pond Retrofit (Parkwood)	\$120,000
FY 14	Sub-Regional Opportunity Fund	~\$64,000
FY 15-17	Ecology Biennial Capacity Grant	\$50,000
FY 16	Ecology Natl. Estuary Program Grant	\$199,674
FY 17-19	Ecology Biennial Capacity Grant	\$50,000
	Total	\$959,908



Given the many demands on City funds and the limited applicability of developer capital charges, the City will need to secure significant amounts of grant funding to fully implement the CIP. Ecology grants may be available for major retrofit improvements including the projects identified in this Plan, and local, regional, state, and federal grants may be available for other types of projects.

Developer Capital Charges:

Improvement projects R-1 to R-12, C-1 to C-6, I-1 to I-7, and O-11 are eligible for developer capital charge funding. The proportion of Developer Capital Charges to total project cost for these projects were developed based on the ratio of existing development with respect to the forecast of total anticipated development within the 2015 Comprehensive Plan. This calculation is shown in Table 7-3.

Table 7-3. Existing and anticipated changes in development within the City

	Parcel Area (Acres)	Dwelling Units	
2015 Existing Total Development	963	2,657	
2035 Anticipated Total Development	1412	3,884	
2015-2035 Anticipated Change in Development	449	1,227	
2015 – 2017 Actual Development	20	145	
2018 – 2035 Anticipated Change in Development	429	1082	
% Increase 2018-2035	43.64%	38.62%	
Average %	41.13%		

City Funds:

City funds for stormwater improvements come from the City's general fund. The amount of City funding required to complete each project was derived by subtracting potential Grant funding and Developer Capital Charges from the total project cost.

7.4 IMPLEMENTATION SCHEDULE, PERFORMANCE MEASURES AND STRATEGIES

7.4.1 IMPLEMENTATION SCHEDULE

This section provides a framework for the City to prioritize and fund the improvements identified in this document. The schedule is based on short, mid, and long-term timelines developed based on factors such as project priority, the opportunity for partnerships with other entities, and possible efficiencies associated with adjacent private or public construction projects. The implementation schedule also considers grant opportunities, and associated coordination with other jurisdictions such as Ecology and



King County. Other considerations include the need to address existing infrastructure issues and programs to ensure coordination with development to address issues and fund stormwater improvements necessary to support new growth.

7.4.2 Performance Measures

Elements of the Comprehensive Plan and this Surface and Stormwater Plan anticipate the needs and conditions of future stormwater infrastructure, which allows the City to plan until the 2035 horizon year. Regular updates are necessary to ensure the plan remains current and relevant. The planning and financing strategies outlined in this document attempt a balance between revenues and expenditures over the life of the Plan. However, the City is committed to reassessing their stormwater needs and funding sources each year as part of their annual Six-Year CIP update. This allows the City to match the financing program and other opportunities with the shorter-term improvement projects, funding, and grant opportunities.

7.4.3 Monitoring and Evaluation Strategy

The City will go through a formal process of updating the Plan every five to eight years as part of the City's regular Comprehensive Plan amendment cycle, which ensures proposed changes go through a public review process before the amended Plan is adopted by the City. Proposed updates may include shifts in City priorities, compliance with regulations and requirements, or the changes in the relevance of certain Plan components.

The City will review identified projects and programs and assess whether the CIP is adequately addressing the implementation strategies necessary to ensure the stormwater infrastructure continues to grow in line with the City's objectives. Establishing and implementing a re-evaluation process allows the City to understand progress made while implementing the CIP, as well as identifying new needs that have developed since the previous update.

As part of this process, the City will review its future project list and update the CIP as needed. Policies, strategies, and funding approaches will also be evaluated to ensure consistency with the City's vision, regulatory requirements, and future funding opportunities. The City will apply the following principles to maintain and develop this Plan and the City's stormwater system:

- Balance improvement costs with available revenues as part of the annual Six-Year CIP Update process;
- Coordinate with local and federal agencies to secure grants and other funding for improvements;
- Pursue grants and economic assistance programs to improve Old Town water quality in accordance with the NPDES Permit, and;
- Work with private developers to implement LID improvements as identified in this Plan and with respect to the Goals & Polices within the City's Comprehensive Plan and other relevant Plans, Programs, Codes, and Standards.



7.5 CHAPTER 7 REFERENCES

City of Duvall, 2017 (and as amended) City of Duvall 2017 Transportation Plan. Available: http://www.duvallwa.gov/documentcenter/view/4355

City of Duvall, 2016 (and as amended) City of Duvall 2015 Comprehensive Plan (Resolution No. 16-09). Available: http://www.duvallwa.gov/DocumentCenter/Home/View/2974





CHAPTER 8. OPERATIONS AND MAINTENANCE

8.1 OPERATIONS AND MAINTENANCE

Under the 1997 Stormwater Management Plan, the City's stormwater operations and maintenance program had three primary functions (Gardner Consultants, 1997). They were to:

- Maintain the functional use of the public drainage system;
- Maximize the water quality benefits of the existing drainage system facilities; and
- Provide for emergency response to flooding and water quality problems resulting from drainage system restriction, hazardous material spills or illegal dumping.

New federal and state regulations, coupled with a growing population, require the City to update its regulations and operations and maintenance for the management of stormwater. In 2010, the City adopted the KCSWDM, including any subsequent amendments, to help guide these efforts. Since 2007, the NPDES Permit requires the development of a SWMP, which must address the operations and maintenance of post-construction stormwater facilities (as discussed in Chapter 2, Surface and Stormwater Management Background).

Currently, key tasks of the operations and maintenance program include:

- Annual inspections of public and privately-owned stormwater facilities, ensuring proper function and maintenance;
- Annual cleaning and maintenance of pipes, ditches, catch basins, culverts, and other storm drainage system components;
- Repair and maintenance of other structural elements of the storm drainage system, including water quality facilities;
- Cleaning streets and public parking lots to remove sediment, leaves and debris that could plug inlets, catch basins and pipes;
- Routine observation and monitoring of flow and water quality during storm events and wet weather months; Investigating sources of water contamination;
- Training staff for emergency response with regards to hazardous material spills, illegal dumping, and flooding;
- Assembling emergency spill response equipment;
- Develop a plan to deal with heavy rainfall and blockages in highly susceptible and critical drainage systems;
- Construction Site Inspection of TESC plans.



8.1.1 FACILITY AND CONVEYANCE INSPECTION AND CLEANING

There are currently 170 stormwater facilities within the City. Of these, 134 are owned and maintained by the City, with the remaining 36 being privately-owned and maintained. Additionally, the City owns and maintains over 40 miles of stormwater conveyance pipe, approximately 7-miles of ditches, and over 2,000 catch basins.

Annual inspection and cleaning of these facilities is performed to comply with NPDES Permit requirements, as well as in response to reports of localized flooding or other drainage issues. Catch basin inspections and necessary cleaning is also completed by Public Works crew, consistent with updates to the NPDES Permit requirements. The types of stormwater facilities and infrastructure inspected and maintained include:

- Ponds (detention/retention and water quality)
- Tanks, vaults, detention pipes (underground)
- Vegetated (grass-lined) swales and ditches
- StormFilters
- Catch basins/oil-water separators
- Sand Filters
- Infiltration or dispersion trenches
- Conveyance pipe
- Bioretention systems

Traditional stormwater ponds and swales require regular cleaning in addition to mowing, vegetation control, tree removal, and fence maintenance. Cleaning and vegetation control activities help maintain proper function of the stormwater system, which protects downstream water quality and minimizes sediment transport through the system. These activities are completed annually by the Public Works crew.

Currently, the Public Works crew rents a Vac-Truck for four to six weeks during the summer months to perform jet-cleaning of conveyance pipe, and manual removal of sediment and debris to complete catch basin cleanings. All routine and found deficiencies are documented and repaired within one year.





Figure 8-1. Example of a Vac-Truck for catch basin cleaning and conveyance pipe jetting (JDC, 2014)

Catch Basins and Piped Conveyance

Current Catch Basin Inspection and Cleaning Protocol: Catch basins, as well as other stormwater facilities, collect sediment, vegetation, contaminants, and other materials, which build up and can inhibit proper functioning of the stormwater system. When catch basins become approximately 60 percent full, they no longer effectively remove sediment. Therefore, inspection and cleaning is completed by the City at a frequency necessary to avoid catch basins reaching this threshold. The most recent Permit required inspection of all catch basins by August 2017; Public Works met this permit requirement.

The City tracks inspection and cleaning activities through a system of field notes, inspection forms, GIS database, and in-office spreadsheets.

New NPDES Permit Requirements: The NPDES Permit, effective August 1, 2013, requires an increased frequency of catch basin inspection from once every five years to every two years (Ecology, 2017). If it is determined that a catch basin needs cleaning, the work must be done within six months of the inspection.

As of 2017, Public Works staff have split the City into four maintenance zones which allow for the required inspection and cleaning of catch basins to be streamlined. This systematic approach allows approximately half of the City's catch basins to be inspected and cleaned (as required) every year, therefore resulting in 100% compliance with updated NPDES Permit requirements.

Ditches

The City has approximately seven miles of publicly maintained ditches and grass-lined swales, primarily associated with older residential areas surrounding Old Town. Ditches fill with sediment and vegetation over time, reducing their capacity. This occurs naturally, however, improper erosion and sediment control can speed the process. Maintaining grass-lined ditches is important to both slow storm runoff and provide



basic filtration before discharge to downstream receiving waters. Properly maintained ditches sustain conveyance, reduce the risk of flooding, and protect water quality.

The Public Works crew implement regular maintenance of all public ditches, including mowing and weedeating to clear accumulated grasses and other weedy vegetation, and removal of trash debris.

8.1.2 FLOOD RESPONSE AND NON-ROUTINE MAINTENANCE

Significant storm events can trigger the need for emergency maintenance, repairs, or cleaning to protect infrastructure or private property from flooding. The City also performs spot checks of permanent treatment and flow control facilities (not including catch basins) after storm events equal to or greater than 10-year, 24-hour storms and regularly during October through May. If these spot check inspections indicate widespread damage and maintenance needs, the Public Works crew inspects all stormwater facilities that may be affected and conducts appropriate repairs or maintenance actions.

8.1.3 Maintenance Repairs

The City utilizes maintenance standards contained within the adopted KCSWDM. Inspections of stormwater facilities are completed following schedules and standards described in 8.1.1, more detail can be found in the City Facility Maintenance Manual. When maintenance repairs are determined necessary, they are performed as follows:

- Within one year for standard maintenance of facilities (not including catch basins).
- Within six months for catch basins.
- Within two years for maintenance that requires capital construction of less than \$25,000.
- If maintenance cannot be completed within the above time frame, then the City completes the maintenance activities as soon as possible and documents/monitors the circumstances.

8.1.4 SPILL RESPONSE AND ILLICIT DISCHARGE ELIMINATION (IDDE)

The City implements an IDDE program to detect and remove illicit discharge, illicit connections, and improper disposal, including any spills into the stormwater system without a permit. As part of the IDDE program, the City:

- Performs ongoing investigations of stormwater infrastructure:
 - Since 2011 completed annual dry weather outfall screenings at three locations and;
 - o Since 2015 added screenings to the annual catch basin cleaning program.
- Maintains a publicly listed hotline and email for non-emergency reporting.
- Implements ongoing training for IDDE response staff.
- Tracks IDDE activities.

City of Duvall – Surface and Stormwater Plan – Draft



8.1.5 Construction Site Inspection

In addition to annual street sweeping, catch basin cleaning, and infrastructure inspections, City staff inspect sites prior to clearing and construction. During construction activities, City inspectors verify proper TESC BMPs are in place and properly functioning to minimize the probability of silt laden waters leaving the site. Following the completion of construction, City inspectors ensure proper installation and function of permanent stormwater facilities, structures, and conveyance systems.

8.1.6 OTHER MAINTENANCE ACTIVITIES

Street Sweeping: The City hires a third party to conduct street sweeping activities on the last Thursday of every month to prevent flooding or damage to infrastructure or private property. Street sweeping removes debris from the road that can otherwise end up in stormwater infrastructure and increase the need for structure and pipe cleaning. Currently, the streets that are swept include arterials and roadways with ditches and curb and gutters.

Vegetation Management: Most stormwater facilities have a vegetated functional element to slow flows, and improve water quality. Improper maintenance can negatively impact the functionality of these systems, causing widespread problems such as flooding. The City maintains pond vegetation and roadside ditches during the dry months to reduce sediment transportation. LID BMPs such as rain gardens, stormfilters, modular wetland systems, and bioretention swales require a range of specific maintenance techniques. LID BMPs will be maintained per manufacturer specifications and maintenance is the responsibility of the facility owner.

8.2 Review and Recommendations for Operations and Maintenance Best Management Practices (BMPs)

The City has grown rapidly over the last 25 years, with corresponding expansion of public storm drainage infrastructure. This growth, paired with limitations on staffing resources, warrants implementation of new operations and maintenance program BMPs that will provide for greater efficiencies, streamlined and improved tracking, and rapid/consistent identification of facility or conveyance deficiencies.

Recommendation: Implement an asset management system to track maintenance and inspection activities, including utilization of mobile technologies (GPS-enabled tablets) and standardized, digital field forms.

Current erosion and water quality issues stemming from less rigorous, previously required stormwater standards include: increased flows, sediment transport, stream channel erosion, slope failures, and undertreated runoff from PGIS. In the past, actions required to improve these issues have included slope and channel stabilization, upper basin pond retrofits, and downstream culvert replacement. The intent of this



Plan is to go one step further and require implementation (to the maximum extent feasible) LID BMPs to mimic the natural pre-developed environment.

Recommendation: Develop a training program for Public Works staff to understand and successfully maintain LID infrastructure type facilities, which are anticipated to become common place with new development and redevelopment activities in the years ahead. Specific goals of an LID infrastructure training program would include:

- Best practices for maintenance of pervious pavement.
- Best practices for maintenance of bioretention swales and infiltration-type facilities.
 - o If the City is to support vegetated LID facilities with emergent vegetation and/or shrub species, Public Works crew will require direction for annual maintenance needs of these facilities. Additional landscaping and horticulture skills may be required, and additional training may be necessary to support increased maintenance needs.
- Best practices for maintenance of modular wetland systems, Filterra[™], and other emerging technologies.

8.3 OPERATIONS AND MAINTENANCE OF PRIVATE FACILITIES

There are approximately 36 privately-owned stormwater facilities in the City consisting of ponds, vaults, detention pipes, and bioswales. These facilities are inspected annually by Public Works staff. If deficiencies are found, responsible parties are notified in writing and given a time frame in which to correct identified deficiencies.

Private facilities generally drain into City owned and maintained stormwater conveyance systems, and if not properly maintained, these facilities can contribute pollutants and excess sediments to receiving water bodies. If privately-owned facilities operate as designed and are properly maintained, a stormwater utility fee discount is awarded. This process is outlined in DMC 9.06. However, if the privately-owned facilities are not functioning or maintained civil penalties may be applied to the responsible party by the City.

8.4 CHAPTER 8 REFERENCES

Ecology (Washington State Department of Ecology). 2017. Phase II Western Washington Municipal Stormwater Permit web page. Available:

http://www.ecy.wa.gov/programs/wq/stormwater/municipal/phaseIIww/wwphiipermit.html. Accessed November 2017.

Gardner Consultants. 1997. City of Duvall Stormwater Management Plan. Public Works Division of ESM, Inc. April 1997. Available: http://www.duvallwa.gov/DocumentCenter/Home/View/2483. Accessed November 2017.



JDC (Jackey Doheny Companies). 2014. 8 Tips for Purchasing your Vacuum Truck. June 30, 2014. Available: http://www.dohenycompanies.com/8-tips-for-purchasing-your-vacuum-truck/. Accessed November 2017.





CHAPTER 9. POLICIES AND REGULATION

9.1 Overview of Existing Policies and Regulations

9.1.1 SURFACE AND STORM WATER POLICY

Adopted City policies for stormwater management are included in the 2015 Comprehensive Plan, 2015 Watershed Plan and the 1997 Stormwater Management Plan. Adopted policies provide direction for City staff when implementing NPDES Permit requirements and concurrently meeting City priorities for future development and economic growth, infrastructure management, and environmental protection.

2015 Comprehensive Plan

The City's recently adopted 2015 Comprehensive Plan includes goals and policies that are directly relevant to the management of surface and stormwater infrastructure. These goals and policies, along with the other described plans and regulations, are guiding development of the Surface and Stormwater Plan Update. For some of the goals, only one or two of the underlying policies will be relevant. All relevant goals and policies from the 2015 Comprehensive Plan are listed below.

Chapter 2 – Land Use Element

Goal LU-3: Building and site design for residential, commercial, industrial, and mixed-use development promote and ensure visual and functional consistency with adopted plans.

- Policy LU 3.5: Provide flexibility in the administration of design standards to allow for innovative products and creative, effective solutions to site challenges.
- Policy LU 3.9: Update subdivision and site plan standards, as needed, to reflect changes in design methodologies, technology, products, or adopted goals and policies relating to desirable development design.

Chapter 7 – Capital Facilities Element

Goal CF-8: Duvall's stormwater management system is effective, efficient, and enhanced to meet present and future population needs.

- Policy CF8.1: Manage the quality and quantity of stormwater runoff to protect public health, safety, and surface and groundwater quality, and to minimize potential erosion and sedimentation within natural drainage systems such as rivers, streams, lakes and wetlands.
- Policy CF8.2: Require development regulations that encourage the use of Low Impact Development (LID) measures, reduce impervious surface coverage, and retain natural vegetation.



- Policy CF8.3: Require design of new development to allow for efficient and economical provision of storm drainage facilities and require new development to pay general facility charges.
- Policy CF8.5: Comply with all National Pollution Discharge Elimination System (NPDES) Phase II
 permit requirements, including regular review and updates of stormwater development
 standards

Goal CF-9: Transportation improvement plans and programs provide for future road projects throughout the City to allow growth-related improvements.

 Policy CF9.3: When improving new roads, facilities should be undergrounded where feasible, and sewer, water, and stormwater facilities that are in disrepair should be repaired or replaced if funding allows.

Chapter 8 – Environment and Sustainability Element

Goal ES-16: Protect wetlands from encroachment and degradation, and promote wetland restoration, especially at sites that provide important ecological functions.

 Policy ES16.5: Prohibit stormwater management facilities within wetlands and limit such facilities within wetland buffers; ensure that wetland hydrology and water quality is maintained as adjacent development occurs.

GOAL ES-17: Maintain and protect stream resources that provide multiple functions, including surface water transport, fish and wildlife habitat, and aesthetic value.

Policy ES17.4: Manage the quality and quantity of stormwater runoff entering streams, to protect
public health and safety, surface and groundwater quality, and the ecological functions of natural
drainage systems.

GOAL ES-20: Improve important watershed processes and functions through progressive review and updates of land use designations, development practices, and infrastructure improvements.

 Policy ES20.2: Update zoning, subdivision, sensitive areas, and storm drainage standards and other development standards consistent with the subbasin management group framework established in the Watershed Plan.

GOAL ES 21: Improve watershed processes by investing in stormwater infrastructure, parks, open spaces, and restoration in the City's capital improvement program.

- Policy ES21.4: Identify and prioritize stormwater retrofits to address impaired watershed processes and reduce effective impervious surface areas based on the findings of the Watershed Plan.
- Policy ES21.5: Explore the feasibility of building and maintaining centralized stormwater facilities in Management Groups 2B and 2C in the urban growth area (UGA) to offset onsite detention requirements.

Goal ES-23: Improve City-wide stormwater systems to maintain and enhance water flow and water quality processes through implementation of low impact development techniques.



- ES 23.1: Improve stormwater management based on the findings of the Watershed Plan by expanding low impact development requirements, creating incentives, and establishing green infrastructure standards for public roadways in the Duvall Municipal Code.
- ES 23.2: Encourage property owners to use low impact development best management practices for improved stormwater systems by establishing voluntary programs, and partnering with not-for-profit organizations and governmental agencies.

2015 Watershed Plan

The 2015 Watershed Plan provides guidance for improving stormwater management in the City based on watershed assessment results and the subbasin management groups established by that Plan. During development of the Watershed Plan, each strategy was reviewed by the Advisory Committee and ranked by feasibility and importance for achieving the City's stormwater management goals.

Action SW-1: Define the most useful and applicable LID BMPs and require their use in new
development activities. Currently, the City encourages developers to implement LID measures in
accordance with the Public Works Development Design Standards (PWDDS), the requirements of
Appendix A of the NPDES Permit, and requirements of the King County Surface Water Design Manual
(KCSWDM).

The Watershed Plan recommended that new standards for using LID BMPs should be incorporated within stormwater management regulations (DMC 9.06) to reinforce adopted City policies and standards. This section of the Plan detailed LID BMP facility categories (dispersion by maintaining/restoring natural drainage patterns, infiltration/partial infiltration, filtration, and rain capture/reuse), including identification of specific BMPs and potential opportunity for use within the City.

Recommendations under Action SW-1 apply to all subbasin management groups City-wide. As stated in the Watershed Plan "the feasibility of individual strategies varies throughout the City and depends on land ownership, existing topography, soils, hydrology and land cover."

Action SW-2: Improve soil amendment BMP in DMC 14.38.130 for clarity, ease of understanding
and enforcement. The City's current code provides soil specifications for enhancing hydrologic
benefits of disturbed soils (after clearing and grading) and for maintaining soils around existing trees
that are preserved on a development site.

Recommendations of Action SW-2 include suggestions for updating and clarifying these standards, to improve both expectations and outcomes as soil-disturbing activities (land development) occur in the City. Specific subbasins are identified where mapped soils show very low soil permeability, with the suggestion made that these areas would benefit from soil amendments. Recommendations of Action SW-2 apply to all sub-basin management groups City-wide.

Action SW-3: Small-site Stormwater Enhancement. This action recommends defining the most useful
and applicable LID BMPs and stormwater enhancement approaches for small sites, and requiring their
use in new development and redevelopment activities on small sites. The Action also suggests



implementing voluntary and/or incentive-based programs to encourage residential property owners to disconnect downspouts and install rain gardens and rain barrels.

The Watershed Plan recommendations of Action SW-3 should be focused within Management Groups 2B, 2C and 3. Generally, the Watershed Plan notes that application of small-site strategies that include infiltration will likely be more successful in the Old-Town, Coe-Clemmons – Lower, and Cherry Creek B subbasins, than will efforts in other subbasins. The other subbasins have either low percentages of permeable soils or no mapped permeable soils.

• Action SW-4: Establish Flow Control Exemption. The Watershed Plan recommends creating a flow control exemption for portions of the City that are predominantly built-out and already drain directly to the Snoqualmie River through pipe and/or ditch infrastructure. Currently, projects that discharge to the Snoqualmie River floodplain within a ¼ mile of improved flow path (pipes or ditches) are flow control exempt per Section 1.2 of the KCSWDM.

This action refers to portions of the City that already drain directly to the Snoqualmie River through pipes or ditches. Runoff from this limited area does not adversely impact local stream bed and banks and impacts on the Snoqualmie River are negligible. The City could create an expanded flow control exemption for projects in the highly developed Management Group 3 subbasins, to incentivize the increased use of LID BMPs focused on water quality treatment. The City could also consider development of a program to provide stormwater control transfer to focus rehabilitation in priority project assessment units (PAUs), maximizing environmental benefit.

- Action SW-5: In UGAs, explore opportunity for centralized stormwater facilities to off-set onsite
 detention requirements. Current City code does not prohibit centralized stormwater management
 approaches, but also does not establish a preference for such facilities. This Watershed Plan action
 suggests that such approaches should be considered in areas where significant development is
 expected, and where there is sufficient open space and conditions to warrant a centralized approach.
 This action is identified as a lower priority strategy, applicable to subbasin management groups 2B
 and 2C within the UGA.
- Action SW-6: Incentivize stormwater LID standards. "LID BMPs could be encouraged throughout the
 City using an incentive program. Incentives that could be considered include a relaxation of buffer
 limits for sensitive areas (especially in subbasins within subbasin management groups 2C and 3), or
 allowances that provide additional development opportunity within a given site (density increases,
 increased lot coverage, or other similar strategies)."
- Action SW-7: Improve Standards for Landscape Strips in Roadways. "Adjust the landscape strip for street trees to be a minimum of 6-8 feet in width to ensure adequate space for successful growth, which would provide the added benefit of increased infiltration and retention of stormwater (SDOT, 2014). An incentive for wider landscape strips could include allowing the proposed increased direct discharge exemption or through providing open space credit when developers dedicate more area for landscape strips. In addition to providing more room for successful landscaping and tree growth,



wider landscape strips also provide opportunities for LID stormwater approaches to be integrated into the streetscape."

As additional recommendations, the action directs the City to consider allowances for; sidewalks adjacent to curb-line on internal roadways (sub-collectors, sub-access and minor access streets), roadways with dedicated on-street parking, and with landscape area adjacent to the residential landscape area. This approach would "provide opportunity to maximize landscape width and viability"; and landscape strip consolidation to one side of the street maximizing available width (within limits).

Action SW-8: Enhance the current City of Duvall NPDES educational outreach program. This
recommendation recognizes the City's existing educational outreach efforts, and suggests updates to
implement other actions within the Watershed Plan and to incorporate new and targeted educational
materials.

1997 Stormwater Management Plan

Although dated, the City's existing Stormwater Management Plan was reviewed for identified goals and policies. The following Water Quality Program goals were established and emphasized by the Plan, given "enforcement by the U.S. EPA of the NPDES Permits as a requirement of Clean Water Act":

- 1. Identify and document the locations, sources, and magnitude of water quality problems within the existing drainage system.
- 2. Institute a program of water quality source control measures, including an expanded operation and maintenance program, regulation of development and private property, and public education with respect to water quality issues.

9.1.2 DUVALL MUNICIPAL CODE REGULATIONS

The adopted Storm Drainage Utility regulations (DMC Chapter 9.06) establish the City's primary mechanism for implementation of the Stormwater Management Program consistent with NPDES Permit requirements. Current components of City's Stormwater Management Program are detailed in Chapter 2 – Surface and Stormwater Management Background. The following summarizes key sections of DMC Chapter 9.06:



DMC Chapter 9.06 Purpose: The City Council finds that this Chapter is necessary to promote sound development policies and construction procedures which respect and preserve the City's watercourses; to minimize water quality degradation and control of sedimentation of creeks, streams, ponds, lakes, and other water bodies; to protect the life, health, and property of the general public; to preserve and enhance the suitability of waters for contact recreation and fish habitat; to preserve and enhance the aesthetic quality of the waters; to maintain and protect valuable groundwater quantities, locations, and flow patterns; to ensure the safety of City roads and rights-of-way; to comply with federal and state requirements; and to decrease drainage-related damages to public and private property.

- DMC 9.06.030 Incorporation of King County manual. Adopts the current edition of the KCSWMD, including any subsequent amendments, as the primary basis for management of stormwater runoff from new development, redevelopment and construction site activities.
- DMC 9.06.035 Illicit discharge detection and elimination. Provides the City Engineer authority
 to develop an inspection program for illicit discharge and illicit connection to surface waters and
 stormwater infrastructure, and additionally defines what constitutes an illicit discharge, and what
 discharges are allowable.
- DMC 9.06.040 Requirements for small parcels. For new development of single family residential lots and duplexes, and other new developments that result in creation or addition of less than 2,000 square feet of impervious area, or clearing/grading activities of less than 7,000 square feet. This section provides Duvall specific criteria primarily for management of runoff during project construction.
- DMC 9.06.050 Requirements for large parcels. For new development and redevelopment
 activities not meeting the small parcel definition, this section provides minimum criteria for
 management of runoff during project construction, for permanent stormwater facilities, and for
 assessment of potential impacts and mitigation for adjacent sensitive areas and downstream
 waters.
- DMC 9.06.060 Operation and maintenance requirements. Establishes minimum standards for ongoing operation and maintenance of all stormwater facilities, supplemental to the standards in the incorporated KCSWDM. See Chapter 8 of this Plan for details.
- DMC 9.06.120 Fees and 9.06.125 Service charges. Provides the City with development fee and service charge authority for operations, maintenance, and capital improvements for surface and stormwater infrastructure. See Chapter 7 of this Plan for details.
- **DMC 9.06.140 Adoption of Comprehensive Plan.** This section adopts the City's official Stormwater Management Plan. The current adopted plan is from 1997, which will be replaced at adoption of this Storm and Surface Water Plan.



9.2 PROGRAMMATIC OPPORTUNITIES FOR SURFACE AND STORMWATER MANAGEMENT

9.2.1 IMPROVED FLOWPATHS TO SNOQUALMIE RIVER AND FLOODPLAIN

Adopted City policy identifies creation of a flow control exemption for portions of the City that are predominantly built-out and already drain directly to the Snoqualmie River and associated floodplain through pipe and/or ditch infrastructure (Watershed Plan Action SW-4).

Currently, projects that discharge to the Snoqualmie River and floodplain through a ¼ mile of improved flowpath (human-made pipes or ditches), are flow control exempt per Section 1.2 of the KCSWDM. Both the Department of Ecology and King County designate the Snoqualmie River as a "major receiving water" eligible for the direct discharge exemption. For projects that are determined eligible for this flow control exemption, discharges cannot be conveyed through tributary streams or hydrologically sensitive wetlands.

By providing limited expansion of the area eligible for direct discharge exemption, the City will provide additional opportunity or incentives for development and redevelopment consistent with 2015 Comprehensive Plan priorities. This Plan sets a framework and identifies policies and development review criteria that:

- 1. Are consistent with KCSWDM allowances
- 2. Require use of LID BMPs to improve water quality from existing and new impervious surfaces
- 3. Ensure adequate evaluation is provided of the downstream flowpath between the development site and the floodplain.

Limited Geographic Direct Discharge Expansion: The expansion of the existing flow control exemption would only apply to properties occurring in Management Group 3 subbasins (prioritized by the 2015 Comprehensive Plan and 2015 Watershed Plan for additional development) where runoff is already conveyed to the Snoqualmie River floodplain through pipe and/or ditch infrastructure (see Old Town, Coe-Clemmons – Lower, and Thayer Creek subbasins on Figure 1-1).

Once implemented, Public Works should consider whether additional development opportunity, and/or development cost-savings, provide adequate incentive for applicants to implement qualifying criteria within the direct discharge expansion area. If additional participation is seen as a priority for Public Works to facilitate developments that use LID, and are consistent with the 2015 Comprehensive Plan, then Public Works should consider use of additional incentives for qualifying projects. Incentives could include reduced stormwater impact fees, increases in development opportunity, and/or other strategies identified based on community and/or development interest input.

Direct Discharge Expansion Qualifying Criteria:



- 1) Low Impact Development: To be approved for "extended" flow control exemption, proposals must maximize implementation of LID approaches per KCSWDM Core Requirement 9, reducing site runoff through use of permeable pavers or grassed modular grid pavement, pavers or wheel strip driveways, amended soils, and planting of trees, or other approved alternatives.
- 2) Low Impact Development: Ensuring the soil moisture holding capacity of new pervious surfaces throughout the development site.
- 3) Downstream review: Ensure consistency with requirements for Direct Discharge Exemption (page 1-41 of the KCSWDM).
- 4) Core Requirement 2 review per KCSWDM for any projects discharging to surface waters (wetlands and/or tributary streams) within the Snoqualmie River floodplain (as opposed to improved conveyance all the way to the Snoqualmie River channel):
 - a) Erosion completing downstream analysis from the point of discharge through to end of tributary surface water. Level 1 review, and potentially Level 2 if warranted.
 - b) Temperature Requiring implementation of on-site and off-site measures focused on tributary surface water temperature. Provide shrub vegetation around on-site swale features to add additional shade. Implement offsite riparian planting within floodplain open space areas, targeting stormwater outfall into wetlands, tributary streams and other opportunities to increase shade over surface waters.
 - c) Annual monitoring of sensitive receiving areas within the floodplain after project completion. Review would assess channel and bank conditions (tributary streams) or changes in hydrology (wetlands) to ensure no indications of new erosion or other adverse impacts over a 5-year monitoring period. Adaptive management required when necessary.
 - Built-in "adaptive management" requirements if new indications of erosion or other adverse impacts are observed – could include providing bank and bed control measures at targeted areas (bank plantings, large woody debris, and/or other grade control structures within the channel), or native plantings within wetland areas appropriate to post-project conditions.

Page 9-8



9.2.2 Low Impact Development Toolbox for Future Development

To implement LID measures consistent with Duvall landscape conditions and anticipated development patterns, the City established a toolbox of required and optional/incentivized LID measures. Table 9-1 indicates all LID measures required and incentivized for development, and development-type specific tables on the following pages indicate preferred LID BMPs that must be considered for all developments requiring flow control and water quality treatment.

Table 9-1. LID measures required by project type.

Development Type	Maintain Natural Drainage	Protect Wetlands	Protect Streams and Rivers	Soil Amendment	On-Site Stormwater Management	Flow Control	Water Quality Treatment	Native Vegetation Retention or Revegetation	Minimize Impervious Surface Coverage
SFR on existing lot	R	R	R	R	R	NR	NR	0	0
SFR Short plat	R	R	R	R	R	R	R	0	0
SFR Long plat/subdivision	R	R	R	R	R	R	R	0	0
Multi-family residential and non-residential developments (e.g., commercial, institutional, mixed-use)	R	R	R	R ¹	R	R	R	0	O
Roadway	R	R	R	R ¹	R	R	R	NR	NR
Sidewalk/trail	R	R	R	R^1	R	NR	NR	NR	NR
	\mathbf{R} = Required, \mathbf{O} = Optional/Incentive-based, $\mathbf{N}\mathbf{R}$ = Not required/Not applicable								

^{1.} Protect and amend soil in areas not being developed, where feasible.



The following provide standard descriptions for LID measures identified in Table 9-1. During implementation of the LID toolbox into storm drainage standards for future development and redevelopment, Duvall will review each LID measure category to establish development-type specific criteria.

<u>Maintain Natural Drainage:</u> Drainage patterns shall be maintained and discharges shall occur at the natural location, to the maximum extent feasible. Stormwater discharged from the site, retained or infiltrated on-site, shall not cause a significant adverse impact to receiving waters or downstream or upstream properties.

<u>Protect Wetlands</u>: Projects discharging into a wetland or its buffer, either directly or indirectly through a drainage system, shall prevent impacts to wetlands that would result in a net loss of functions and values.

<u>Protect Stream and Rivers:</u> Projects discharging to a stream or river (either directly or indirectly through a drainage system) shall maintain the water quality of any affected stream or river by selecting, designing, installing, and maintaining permanent controls.

<u>Soil Amendment:</u> Retain and protect undisturbed soil in areas not being developed. Prior to completion of the project, amend all new, replaced, and disturbed topsoil (including construction laydown areas) with organic matter.

<u>On-Site Stormwater Management:</u> Manage stormwater at its source; applicable on-site stormwater management BMPs include, but are not necessarily limited to: dispersion structures, infiltration trenches, rain gardens, bioretention facilities, rainwater harvesting, permeable pavement, vegetated roof systems, cisterns, drywells, etc.

<u>Flow Control</u>: Detention/retention facilities must be designed to match the pre-developed (forested) flow duration standard.

<u>Water Quality Treatment:</u> Water quality treatment BMPs shall be installed to treat flows from pollution generating impervious surfaces.

<u>Native Vegetation Retention/Revegetation:</u> Provided via interception, transpiration, and increased infiltration by retaining existing or installing native vegetation (trees and shrubs).

<u>Minimize Impervious Surface Coverage:</u> Minimize impervious surface coverages, below the maximum allowed by City code.

To meet required flow control and water quality treatment BMPs, the development-type specific tables below indicate preferred LID BMPs that must be considered for all developments requiring flow control and water quality treatment. BMPs are listed in priority categories (1 - 4, and Optional, Incentive-Based BMPs). The City will require use of BMPs within higher priority categories; when lower category BMPs are proposed, development applicants will be required to document that higher category BMPs would not be feasible.



Table 9-2. Single-family residential (platted subdivisions), Multi-family

Category	BMP
1	Full Dispersion
	Infiltration Trenches
	Bioretention
2	Dry Wells
	Permeable Pavement
	Sheet Flow Dispersion
	Concentrated Flow Dispersion
3	Splash-block Downspout Dispersion
	Trench Downspout Dispersion
4	Perforated Stub-out Connections
	Site Soil Improvements
Optional, Incentive-	Single-family Residential Cisterns
Based	Newly Planted Trees
	Rain Gardens
	Rainwater Harvesting
	Vegetated Roofs

Table 9-3. Roadway, Trails, and Sidewalk Projects

Category	BMP		
1	Full Dispersion		
	Trench Drains		
2	Bioretention		
	Sheet Flow Dispersion		
3	Permeable Pavement Surfaces		
	Newly Planted Trees		

Table 9-4. Commercial Projects (may use Table 9-2 when applicable)

Category	BMP
1	Full Dispersion
	Trench Drains
2	Bioretention
	Stormwater Filtration
	Permeable Pavement Surfaces
3	Sheet Flow Dispersion
	Concentrated Flow Dispersion
	Newly Planted Trees



9.3 RECOMMENDATIONS FOR PLAN IMPLEMENTATION

PLACEHOLDER

9.4 RECOMMENDATIONS FOR MUNICIPAL CODE AND DEVELOPMENT STANDARD UPDATES

PLACEHOLDER

9.5 CHAPTER 9 REFERENCES

No references for this Chapter.

